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ASTM BULLETIN

MAY 1954

Number 198

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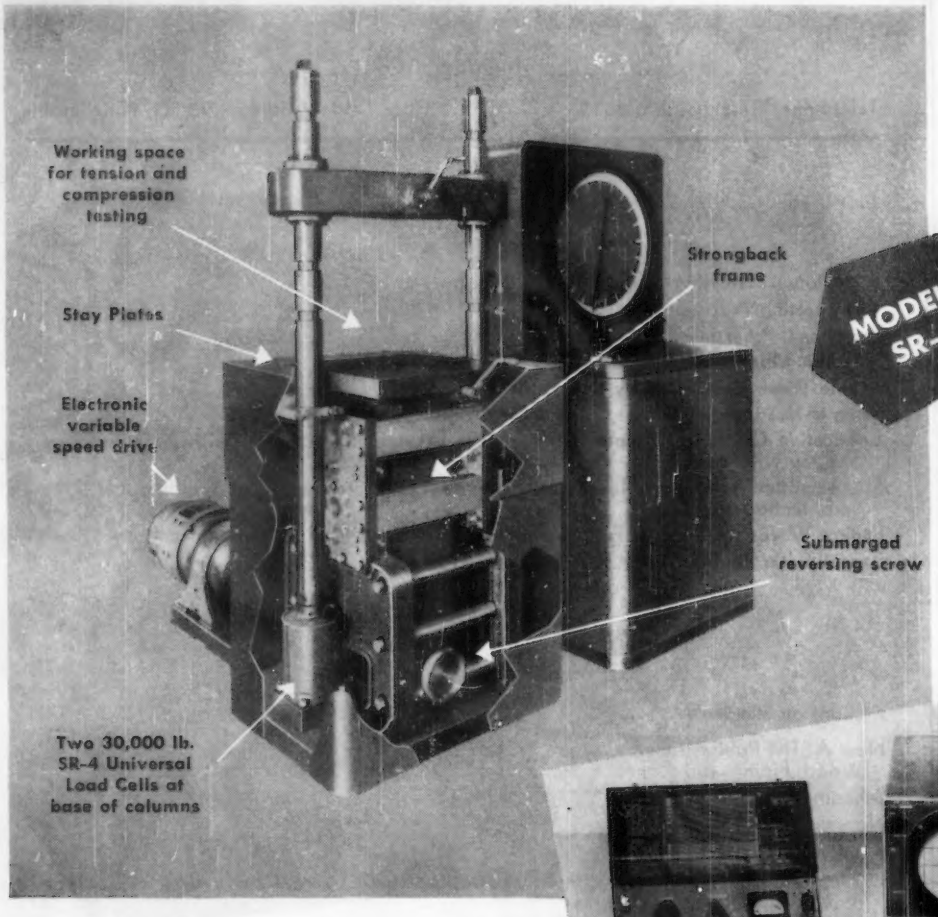
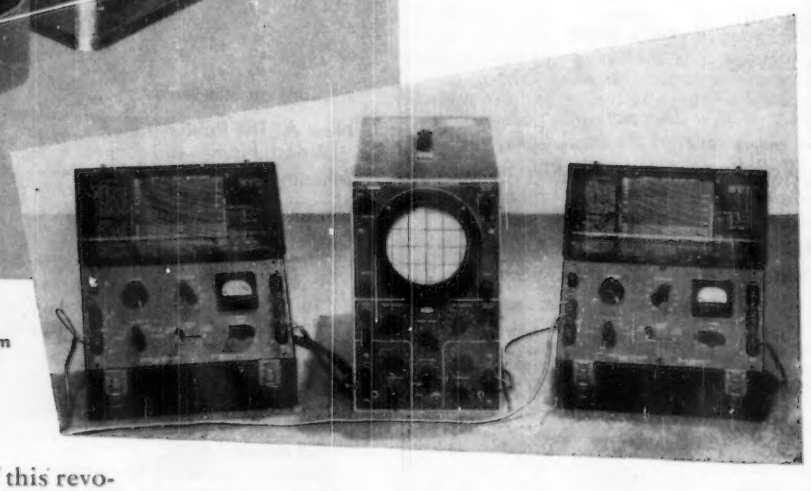
NOW! A Machine Fast Enough for SHOCK Tests on Structures


Working space for tension and compression testing
Stay Plates
Electronic variable speed drive
Strongback frame
Submerged reversing screw
Two 30,000 lb. SR-4 Universal Load Cells at base of columns
MODEL FGT BALDWIN-EMERY SR-4 TESTING MACHINE



Oscilloscope X-Y diagram system records stress-strain curves in shock testing

The extraordinary high speed of response of this revolutionary new Baldwin-Emery universal testing machine, paired with an oscilloscopic X-Y diagram, enables it to measure and record shock tests on complete structures. Its SR-4 load cells and SR-4 type extensometer make it capable of responding to the rates required by shock conditions.

The load cells and extensometer feed signals to the oscilloscope through pre-amplifier circuits. An instantaneous stress-strain curve and its two axes then appear on the oscilloscope screen. It is possible to have this screen photographed continually to record changes in the shape of the stress-strain curve as the structure itself changes.

Its unique aptness for such shock tests is one of the reasons why the FGT SR-4 Testing Machine is being recognized as *the greatest advance in materials testing equipment in twenty years.*

Full details on this latest contribution of Testing Headquarters are in Bulletin 4202. For your copy, write to Dept. 2203, Baldwin-Lima-Hamilton Corporation, Philadelphia 42, Pa.

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ASTM BULLETIN

"Promotion of Knowledge of Materials of Engineering, and Standardization of Specifications and Methods of Testing"

Number 198 MAY, 1954

57th Annual Meeting Will Feature Extensive Technical Program, Gillett and Marburg Lectures, Apparatus and Photographic Exhibits

Thirty-Six Technical Sessions, Including Six Symposiums, Hundreds of Committee Meetings, Attractive Ladies Entertainment Dinner-Dance—Chicago, June 13—18

THE Chicago Committee on Arrangements, faced with a typical "meeting-packed" type of Annual Meeting for the Society—thirty-six Technical Sessions and hundreds of Committee Meetings—has prepared one of the most interesting entertainment programs offered to ASTM members and their wives. These supplement the usual "even-year" attraction of a most interesting Exhibit of Technical Apparatus and Equipment and the Photographic Exhibit. The various entertainment features are so arranged that most of our members will be able to take advantage of them and still attend the many meetings and sessions which are their primary purpose for coming to an ASTM meeting.

Technical Program

From the Provisional Program, which appears on the following pages, it will be seen that the thirty-six technical sessions include the following six symposiums:

Coal Sampling
Temperature Stability of Electrical Insulating Materials
Odor
Permeability of Soils
Effect of Cyclic Heating and Stressing on Metals
Building Constructions

In addition to the symposiums, three sessions are devoted to papers on Fatigue; the others cover a range of subjects such as Soils, Significance of Tests of Concrete, Bituminous and Road Materials, Creep, Plastics, and Impact Testing. Recognizing this diversity of the typical ASTM meeting, the Chicago Committee sought to arrange one session which would be of interest to everyone in attendance. This they have done in arranging the Tuesday morning session on Significance of Specifications.

Significance of Specifications

What promises to be a very interesting session on the Significance of Specifications and Standards is being sponsored by the Chicago General Committee on Arrangements. With the close

Provisional Program

The Provisional Program of the 57th Annual Meeting, outlined on page 16, is designed to give members a comprehensive picture of the sessions, symposiums, and special events of the meeting. Brief abstracts of the papers are provided as well as general statements of the scopes of some of the symposiums.

The official Program which members and guests will receive when they register will contain full and final details of the sessions, a complete schedule of committee meetings, and the when and where of the entertainment features of the week.

Lake Michigan and Chicago's Gold Coast *Kaufmann and Fabry*

The Marburg Lecturer. . .

Harold F. Dodge, *Quality Results Engineer, Bell Telephone Laboratories, closely associated with W. A. Shewhart, quality control pioneer, has had a distinguished record of achievement in his field and in his service to the Society. He has served as chairman of Committee E-11 on Quality Control since its organization in 1946 and was chairman of the committee which brought forth the ASTM Manual on Presentation of Data.*

During World War II, Mr. Dodge served as Consultant to the Office of Chief of Ordnance, one of a small group that developed Army Ordnance (and A.S.F.) Standard Sampling Inspection Tables. In 1950 he received the ASTM Award of Merit and in 1949 the Shewhart Medal of the American Society for Quality Control.

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cooperation of Chairman A. Allan Bates, Vice-President of Research and Development, Portland Cement Assoc., J. J. Kanter, Directing Engineer, Engineering Laboratories, Crane Co., chairman of the local program committee, has arranged for several leading men to review this subject from their specific viewpoints.

The philosophy underlying this session, which will be the chief technical feature Tuesday morning, June 15, at the Sherman, is that while we in ASTM devote intensive efforts to standards work and development of data, much of which is used in the promulgation of widely used specifications, it is desirable that occasionally we review some of the broad principles underlying this work and stress the economic significance of standards.

As indicated in the provisional program, a general introduction and background will be presented by Executive Secretary R. J. Painter, to be followed by short talks by A. W. F. Green, Chief Metallurgist, Allison Division, General Motors Corp., speaking from the consumer's viewpoint; A. O. Schaefer, Vice-President in Charge of Engineering and Manufacturing, The Midvale Co., presenting the producer's viewpoint; and, because of the tremendous significance of the work on standards in the Defense Dept., information on those activities will be presented either by Roger F. Hepenstal, Director, Cataloging, Standardization and Inspection, or Captain C. R. Watts, Staff Director, Standardization, Office of Assistant Secretary of Defense (Supply and Logistics). This session will be in the form of a round table, followed by a question and answer period. All members are cordially invited and urged to attend.

Marburg Lecture

Harold F. Dodge, Quality Results Engineer, Bell Telephone Laboratories, Inc., will present the 28th Edgar Marburg Lecture, "Interpretation of Engineering Data," Wednesday afternoon, June 16.

This lecture originated as a memorial to the first Secretary of the Society and was established to emphasize the importance of furthering knowledge of properties and tests of engineering materials.

In industry, the development and production of materials and manufactured products involve at every turn the collection, analysis, and interpretation of quantitative data. Most engineering data can advantageously be regarded as a sample to tell something about a larger whole or about the behavior of the cause system or process that gave rise to the data. Mr. Dodge will give particular attention to the application of some of the simpler statistical methods in the interpretation of data obtained in development, production, and inspection activities, and will discuss the role played by sampling and quality control techniques.

Gillett Lecture

Richard L. Templin, Assistant Director of Research and Chief Engineer of Tests, Aluminum Company of America, will present the third Gillett Memorial Lecture, Tuesday afternoon, June 15.

This lecture is jointly sponsored by the American Society for Testing Materials and Battelle Memorial Institute and commemorates Horace W. Gillett, the first Director of Battelle, and one of America's leading technologists and metallurgists. Its scope covers subjects pertaining to the development, testing, evaluation, and application of metals.

After discussing the phenomenon of fatigue of metals and the mechanism of

The Gillett Lecturer. . .

Richard L. Templin, *Assistant Director of Research and Chief Engineer of Tests, Aluminum Company of America, has been with his company for 35 years in which period he has been personally responsible for the development of many of the testing methods used today in inspection and quality control of aluminum products, and has conceived and designed much of the physical testing equipment in use in Alcoa's Laboratories.*

Mr. Templin holds a number of patents on aluminum fabrication and testing equipment and has written nearly 100 papers in this field.

He is a past-president of ASTM, Dudley Medal winner in 1934, and is an active member in several other engineering and metallurgical organizations.

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fatigue failure, Mr. Templin will describe in detail various factors that affect the fatigue strength of metals, specifically aluminum alloys. He will discuss such factors as alloy composition, heat treatment, grain size, residual stresses, design, fabrication, and environment, making liberal use of charts and diagrams to illustrate their effects. The lecture will apprise the designer of the difficulties of applying test results directly to the design of machines and structures emphasizing the usefulness of fatigue tests of structural components and assemblies.

Entertainment Features

An extensive entertainment program has been planned for the members and their wives. Arrangements for inspection trips have been made with several laboratories in the vicinity of Chicago. Arrangements for these trips may be made at an information desk which will be manned by members of the local committee.

Dinner-Dance

The Annual ASTM Dinner-Dance will be a welcome pause in a busy week. A cocktail party (dutch treat) will precede a dinner "delux" and floor show, featuring nationally known entertainers who have played in some of the largest theaters and hotel ballrooms in the country—all this followed by an evening of dancing. Local committee funds make it possible to provide all of the evening's food and entertainment to our members at a price per ticket equal to about half the actual cost. This evening, with no speeches or talks, will be entirely set aside for relaxation and an opportunity to meet one's fellow members.

Ladies Entertainment

The local committee has made every effort to have the Chicago meeting long remembered by the ladies. Each day will begin with a Coffee Hour in a room set aside "for ladies only" to be followed by special features throughout the week: Lucille LaChapelle in "You Are Better Than You Sound" (a humorous demonstration of the basic vocal qualities you hear every day and the personalities they imply); afternoon tea; daily tickets for Don McNeill's Breakfast Club; Luncheon and Puppet Show at the famous Kungsholm Restaurant and Theater; Tommy Bartlett's "Welcome Travelers" radio and television broadcast; sightseeing tours through the University of Chicago campus and Northwestern University; special interest tours to the Art Institute, Oriental Institute, Field Museum, Aquarium, Planetarium, and Marshall Field and Co.; luncheon and style show at Chez Paree; and, of course, the Annual ASTM Dinner, floor show, and dance.

All of the ladies entertainment features will be subsidized through local committee funds to the extent that to all those purchasing a Dinner-Dance ticket no further charge will be made. Others will be charged a token fee. As pointed out on preceding page, the charge being made for the Dinner-Dance represents about one-half the actual cost.

President's Luncheon

We are again following the plan started several years back of having the President's address, various recognitions and awards, and introduction of new officers at a luncheon session. Retiring President L. C. Beard's address is entitled "Plain Talk." The various awards include: awards of honorary memberships to individuals of widely acknowledged eminence in the fields of work covered by the Society, or who have rendered especially meritorious service to the Society; Awards of Merit to individuals who have rendered distinguished service to the Society along technical lines; recognition of 50 and 40-year members. Members can attend this luncheon without conflict with the other meetings and technical sessions they must attend.

Committee Meetings

The detailed list of committee meetings to be held throughout the week will be included in the program available at the Annual Meeting. Approximately half of the meetings will be held at the Morrison Hotel and the other half at the Sherman. An advance tentative outline of these committee meetings was included in the letter transmitting hotel reservation forms to our members on April 1. As has been pointed out in the letter, members should consider the committee meeting schedule as tentative, to be superseded by the call of meetings by committee officers; in other words the official notice for committee meetings and subcommittee meetings will be received directly from the secretary of each committee.

Preprints of Papers and Reports

Each member should have received by now a preprint request blank which was mailed to the entire membership on April 9. The First Installment of preprints should go in the mail about May 7. All papers and reports included in this first installment that have been requested will be included in this mailing. A second and third mailing installment of preprints will be made May 21 and June 5, respectively. Those registering at the Annual Meeting will have another opportunity to secure preprints of the various reports and papers by virtue of their registration fee. It should be borne in mind however, that all reports and papers may not be available in time to be preprinted.

On the Lighter Side—

—LADIES PROGRAM—

Coffee hour—every day
Entertainment—Lucille LaChapelle "You Are Better Than You Sound"
Don McNeill's Breakfast Club (Radio and T-V Broadcast)
Luncheon and Puppet Opera—Kungsholm Restaurant and Theater
Tommy Bartlett's "Welcome Travelers" (Radio and T-V Broad cast)
ASTM Dinner-Dance
Luncheon and Style Show—Chez Paree
Sightseeing Tours

—ASTM DINNER-DANCE—

Cocktail Hour—"Dutch Treat"
Dinner "Delux"
Floor Show
Dancing till 1 a.m.

Hotel Reservations

The Society's meetings will be held at both the Sherman and Morrison Hotels. The Exhibit and most of the Technical Sessions will be held at the Sherman Hotel and the Committee Meetings are divided about equally between the hotels. It is expected that members will wish to have sleeping accommodations where most of their meetings are being held.

Those members who have not as yet returned their hotel reservation form are urged to do so immediately. May 15 is the final date which the hotels have agreed to reserve sleeping rooms for ASTM use. Obviously no hotel should be expected to hold empty rooms throughout our meeting week.

A Plan for Better Presentation of Technical Papers

As announced to the members in the February, 1954, ASTM BULLETIN, p. 16, the Society's Administrative Committee on Papers and Publications will try out a new plan which is intended to obtain livelier, more stimulating sessions by improving the character of presentations of technical papers.

Reporters (not judges) will be chosen by each session chairman and asked to fill out a standard report card for each paper they hear. The check lists include items usually concerned with effective presentation. Copies will be sent, in advance, to each author who will present a paper at the Annual Meeting.

During a presentation, the reporter, by check marks and one-word replies, will complete a comprehensive, objective statement of what the speaker does and these statements will be evaluated by the Papers Committee.

No awards and no criticisms will follow but any author may obtain his check sheet and learn how his presentation was received.

Ideas for refinement and improvement of the system will be welcomed from anyone; these should be sent to the chairman of the Administrative Committee on Papers and Publications at Headquarters. Volunteer descriptive comments on particularly well-presented papers would be especially helpful.

Kaufmann and Fabry

Chicago's Natural History Museum contains, among other remarkable objects, a unique exhibit—the work of sculptor Melvina Hoffman—depicting types of modern man in 101 great bronzes.

Photographic Exhibit—Materials, Testing, Research

AN attractive feature of the Annual Meeting and Exhibit will be the Ninth Photographic Exhibit with the theme Materials, Testing, and Research. Three outstanding sections will make it of more than ordinary interest: Prof. Antonio Scortecci, Istituto Siderurgico, Genoa, Italy, will be exhibiting a special display of color photomicrographs; B. W. Mott, Atomic Energy Research Establishment, Harwell, England, will have on display a group of photomicrographs taken with polarized light and opaque stops; the Traveling Print Show from the 1953 Photographic Society of America Technical Exhibit will include 29 prints of a variety of scientific subjects from astronomy to zoology.

This BULLETIN goes to press well in advance of the deadline for photographic entries; therefore, the exact number of prints which will be available is not known. Based on past experience, however, and due to the fact that invitations to take part were distributed several months earlier than usual this year to allow greater time for preparation, it is expected a very fine collection of photographs will be available for display.

Entries are expected in the following classifications: (*a*) black and white or monochrome prints, (*b*) color prints, (*c*) color transparencies, (*d*) photomicrographs, (*e*) electron micrographs. A special section will be devoted to student entries in photomicrography. The student exhibit will be divided into two groups, general competition, and restricted competition.

J. G. Heiland, Assistant Director of Research, Bell & Howell Co., is chairman of the local subcommittee in charge of the Photographic Exhibit assisted by Cornelius Johnson, Armour Research Foundation; E. J. Kolb, Bell & Howell Co.; R. F. Main, Acme Steel Co.; L. B. Marsh, Inland Steel Co.; C. C. Oleson, Portland Cement Assn.; and Wm. C. Wilke, Jr., Crane Co. Representing Committee E-4 on Metallography are D. I. Finch, Leeds & Northrup Co.; W. L. Grube, General Motors Corp. and S. W. Poole, Republic Steel Corp.

The Traveling Print Show of the Photographic Society of America (Below) will again be a feature of the Photographic Exhibit at the Annual Meeting.

Entries from Abroad in the ASTM Photographic Exhibit

ON the recommendation of Committee E-4 on Metallography, special efforts have been made for the first time by the Headquarters Staff to invite interested parties in other countries to participate in the photomicrography section of the ASTM Photographic Exhibit.

Approximately 40 replies have been received from abroad asking for further information. The nations involved are: Australia, Belgium, Canada, Chile, England, France, Israel, Italy, Japan, Malaya, Netherlands, New Zealand, and Pakistan.

Two special exhibits have been arranged. Professor Scortecci of the University of Genoa will send examples of his outstanding work in color metallography. B. W. Mott, Atomic Energy Research Establishment, Harwell, England, has also agreed to arrange an exhibit of his special work in metallography, including the use of opaque stops and polarized light.

1954 Testing Apparatus Exhibit to Be Largest in ASTM History

New Equipment and Laboratory Supplies Will be Shown by Leading Manufacturers and Distributors at 57th Annual Meeting, Hotel Sherman, Chicago, June 14–18

THE Eleventh ASTM Exhibit of Testing and Scientific Apparatus and Laboratory Supplies will be of great interest to all concerned with research, testing materials, and laboratory and production control operations. Many of the leading manufacturers of apparatus and instruments as well as laboratory supplies are taking part in the Exhibit which will be held at the Hotel Sherman throughout the week beginning June 14. A total of 78 booths have already been assigned making this the Society's largest Exhibit to date. Anyone concerned with apparatus or material in the Exhibit is cordially invited to attend. Registration at the Annual Meeting is not necessary but visitors will be requested to register for the Exhibit where a record is maintained.

The biennial ASTM Exhibit has become a fixture in the materials testing field and members and committee members look forward to this opportunity every other year to see first hand the latest developments in this important technical field. The Exhibit is intimately concerned with the apparatus industry since ASTM methods and specifications in almost every instance involve laboratory apparatus.

The displays will be in the Exhibit Hall of the Sherman and in the upper Mezzanine, which has recently been converted for exhibit purposes. The upper Mezzanine is handily adjacent to the registration desk at the Sherman. The Photographic Exhibit will also be in the upper Mezzanine area, readily accessible to a large number of the technical committee meeting rooms.

Exhibit hours are as follows:

June 14–Monday—	12 noon (opening) to 6:00 p.m.
June 15–Tuesday—	9 a.m. to 9:00 p.m.
June 16–Wednesday—	9 a.m. to 5:30 p.m.
June 17–Thursday—	9 a.m. to 5:30 p.m.
June 18–Friday—	9 a.m. to 1:00 p.m.

The short descriptions which follow are based on information supplied by the exhibitors and indicate both the scope of the Exhibit and the up-to-date nature of the equipment displayed. In many instances the equipment is being shown for the first time.

American Cystoscope Makers, Inc.
Booth 8

Representatives will demonstrate the various types of borescopes which will be on display, including a new design jointed borescope for the examination of pipe welds utilizing a test hole port of entry a few inches distant from the weld.

H. Reeve Angel & Co., Inc.
Booth 23

Glass fiber filter papers will be shown. This comparatively new material is the result of work at the National Bureau of Standards and the Naval Research Laboratory. Glass fiber filter papers are free of organic material in any form either in the fiber or as a binder and are extremely retentive yet very rapid filtering.

Applied Research Laboratories
Booths 32 and 33

The Applied Research Laboratories will display their X-ray Industrial Quantometer. This instrument is particularly useful in performing production control determinations on materials being manufactured. It is a nondestructive test and can be performed rapidly and accurately. The head can be changed and the instrument converted for gaging measurements. X-ray fluorescence techniques then can be applied to measure thickness of tin plate, zinc plate, and similar materials.

Atlas Electric Devices Co.
Booth 35

The Atlas Electric Devices Co. will display for the first time the new Model DMC-R Weather-Ometer. This accelerated weathering instrument in addition to control of radiation, temperature, and other factors provides for automatic control of humidity. This permits the use of dew cycles in which moisture is condensed on the specimens under controlled conditions of temperature and droplet size.

Atmosphere Control Co., Inc.
Booth 61

On display will be the Variable Products Atmosphere Control Cabinet. The Model 24-C Variable is an improvement over the 24-C Standard (G.F.M.V.T.) cabinet since temperature can be varied from 45 to 120 F with R.H. of 35 to 100 per cent. This cabinet may be set also to conduct the General Foods M.V.T. test at 100 F with 92 per cent R.H. This same cabinet may be used for testing packages as well as plastics, rubber, or any material which needs to be tested at a constant temperature and humidity for a definite length of time.

Baird Associates, Inc.
Booth 52

Baird Associates will display a flame photometer presenting a simple method of analyzing sodium and potassium. The only utilities required are "city" gas and compressed air. A completely sealed combustion system eliminates effects of contaminants making an air-conditioned room unnecessary.

The Comparator Densitometer to be shown is a new accessory for emission spectroscopy, a double-beam automatic servo-type instrument calibrated to read photographic densities directly on a linear scale by means of a null balance system.

Baker & Co., Inc.
Booth 60

Baker & Co., Inc. will exhibit their new platinum-wound E-3 furnace for high temperature testing and experimenting. Temperatures up to 1600 C are available. The heating chamber is 1½ in. in diameter and 12 in. long. Laboratory tests reveal remarkably long muffle life. In addition the very popular Baker-Brunjes E-2 platinum-wound furnace for coal ash analysis and other testing and experimental work requiring temperatures up to 2800 F will be shown.

Baldwin-Lima-Hamilton Corp.
Booths 18–21

Baldwin-Lima-Hamilton will have a large exhibit displaying a wide variety of testing apparatus including SR-4 Universal Testing Machine, Stress Strain Recorders, SR-4 Extensometer, and x-y recorder system.

Brookfield Engineering Laboratories, Inc.
Booth 59

Two interesting accessories will be shown in operation with standard Brookfield Synchro-Lectric Viscometers.

The Helipath Stand will be exhibited. This accessory permits the "consistency" measurement of gels and pastes by the rotational method. It has been publicized recently as a method of test for toothpaste in *Chemical Week* magazine.

The U.L. Adapter attachment for a model LVF Viscometer will also be shown in operation. Making possible the quick measurement of low viscosity materials, its use as a method of test has been recently discussed in *Tappi*.

A new Stress-Strain Analyzer is to be shown which will plot the deformation and yield value of a gel under an increasing applied stress.

Buehler Ltd.
Booths 24 and 25

The Buehler display will feature two types of equipment. The latest sample preparation apparatus for metallurgists will be in operation including cut-off machines, grinders, specimen mount presses, fine grinders, polishers, and electrolytic polishers.

The additional, special feature of this exhibit will be selected items of physical testing machines manufactured by Amsler in Switzerland.

Burrell Corp.
Booths 11 and 12

The Burrell exhibit will feature the first public showing of the Fracton, an instrument which provides a means of separating, identifying, measuring, and collecting the components of light hydrocarbon gas mixtures and recording the analytical data.

In addition, there will be displayed other products of Burrell manufacture such as "Wrist-Action" shakers, Combustron and Carbotrane for carbon and sulfur in steel by high frequency combustion, and the more popular models of Burrell gas analysis apparatus.

Central Scientific Co.
Booth 56

One of the newer instruments for research and product analysis to be shown by Central Scientific Co. is the Cenco Beta-Ray H/C Meter which utilizes an atomic radiation source to measure the percentage hydrogen and hydrogen-to-carbon ratio in liquid hydrocarbons. Measurements are obtained in about five minutes with an accuracy of 0.02 weight per cent hydrogen. Percentage hydrogen is an index to the performance of end products as fuel oils, jet fuels, gasolines, etc. The Cenco Beta-Ray is manufactured by Cenco under license by Standard Oil Co. (Ind.).

Curry & Paxton, Inc.
Booth 73

On display will be tintometers and comparators for use in almost every field indicating units for specific applications. Included in the exhibit will be a graphic illustration of the Lovibond Color Scale, showing many of the 600 permanent color standards which in 200 steps provide more than 5 million color combinations for colorimetric analysis. On display will be instruments employing these units for specific applications.

Custom Scientific Instruments, Inc.
Booth 53

Custom Scientific Instruments, Inc. will display an electrical resistance tester developed for the measurement of electrical resistance of fabrics, fibers, films, and other materials; Pittsburgh Corning Thermal Conductivity Probe which utilizes the fact that the temperature at a light heat source in a block of insulating material rises by an amount dependent upon the thermal conductivity of the material; a light load indentation machine for measuring compression and recovery as well as thickness of a variety of materials; Armstrong Small Abrader (Model S); CSI-Templin Calibrator designed for precision checking of extensometers, strain gages, and dial gages; and a microscope stage.

Doble Engineering Co.
Booths 46 and 47

The new Doble Water in Oil Meter for continuously indicating on a deflecting meter the water content in a flowing stream of insulating oil will be shown making measurements which will include water contents below saturation. The Doble Oxidation Comparator for determining the useful life of transformer oil and a laboratory clay treater for estimating the amount of re-refining required for a large volume of oil will also be demonstrated. The latest in the Doble line of power factor test equipment for both solid and liquid insulation will also be displayed.

Eastman Kodak Co.
Booths 26 and 27

The Eastman Kodak Co. will display their full line of X-ray films and chemicals demonstrating the improved quality radiographs which result from use of films having fine graininess and high contrast characteristics. Applications of photography in the fields of photomicrography, electron micrography, spectroscopy, and others will be displayed. An operating demonstration will be given of the Kodak Verifax Printer, an office copying machine for producing copies of typewritten or printed originals rapidly and easily. Copies can be handled or filed immediately.

Encyclopaedia Britannica
Booth 74

The Encyclopaedia Britannica will have on display its World-Language Dictionary of the most frequently used words in seven languages.

The R. Y. Ferner Co., Inc.
Booth 50

The Ferner Co. plans to show for the first time in the United States a new metallographic objective yielding extremely flat fields at high powers. Elimination of the slight deterioration in resolution, contrast, and definition, previously associated with so-called flat field objectives, is claimed. The objective will be shown on the Vickers Metallograph. Those interested are invited to bring polished specimens for examination. Of interest also will be the Chevenard Thermobalance, a new instrument which measures small changes in weight in small specimens over a heat-time cycle.

Fisher Scientific Co.
Booth 4

Fisher Scientific will illustrate the trend to automatic instrumentation by previewing its forthcoming Automatic Titrimeter and demonstrating the newly released Controlled-Potential Electroanalyzer. Featured also will be the modernized Fisher/Tag line of basic oil-testing apparatus, designed to ASTM specifications: the new Saybolt Viscosimeter, the Tag Closed Flash-Point Tester, the improved Cloud and Pour Point Apparatus and the TEL-Meter, a new direct-reading polarograph for determination of tetra-ethyl-lead in gasoline. With them will be the top-speed, high-sensitivity, single-pan Gramatic Balance.

Gaertner Scientific Corp.
Booth 42

The Gaertner Scientific Corp. will exhibit a number of instruments. Some of the equipment will be familiar to members and some new units will be shown. Cathetometers, Comparators, Interferometers, Optical Bench equipment, and a Toolmakers' Microscope are scheduled. Visitors will have an opportunity to use micrometer slides and measuring microscopes in a variety of setups demonstrating the versatility of these precision measuring units.

General Electric Co.
Booths 9 and 10

General Electric will present a variety of testing instruments at the show. Because of the complexity of some of these instruments, the exhibit's emphasis will be placed on actual demonstration and operation of these instruments. Visitors will be invited to participate in these demonstrations, so they may see exactly how they operate. Products featured will be instruments for measuring and recording temperatures, speeds, heat, electrical charges, and material strains and fatigue.

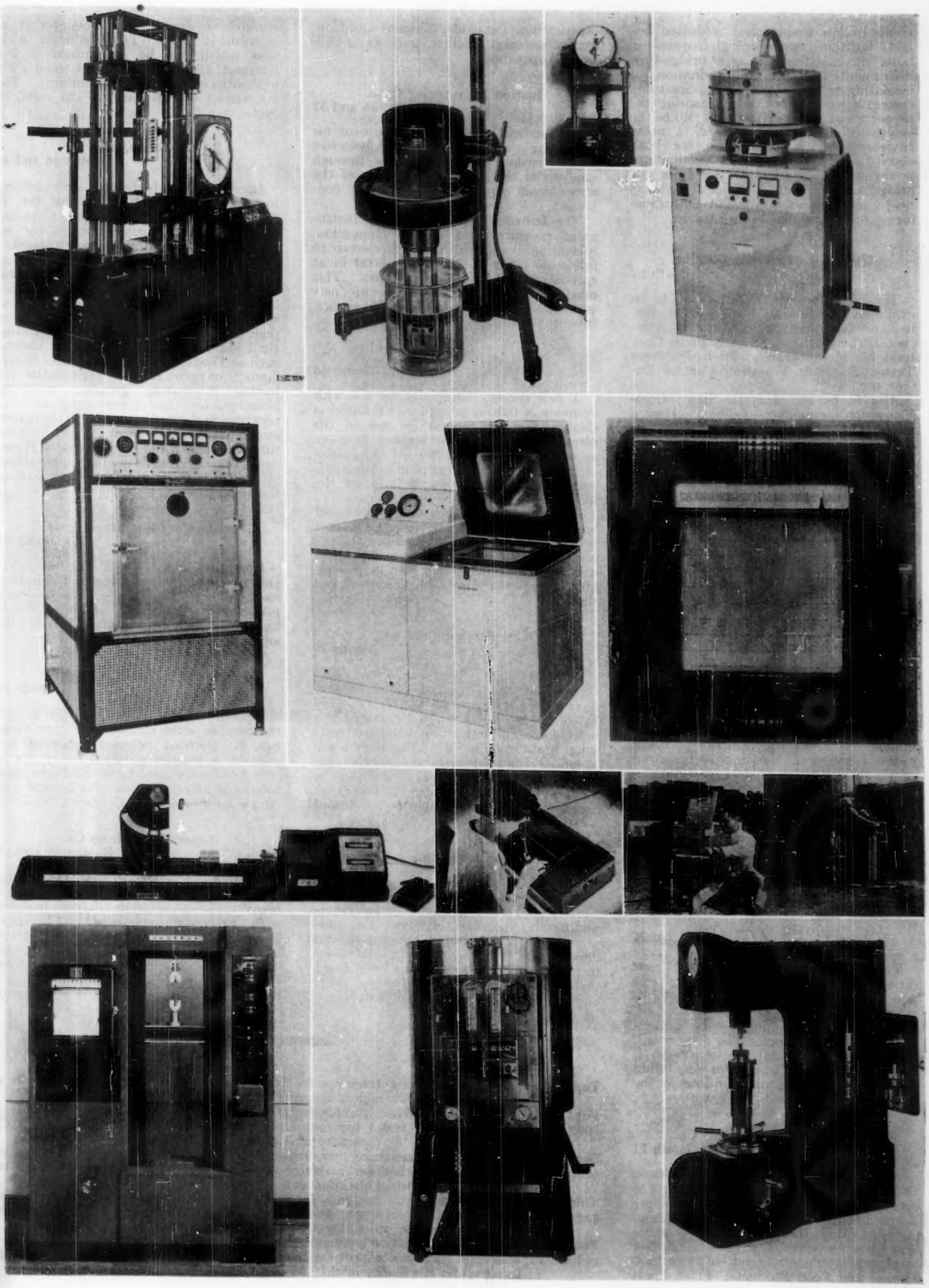
General Radio Co.
Booths 2 and 3

General Radio Co. will display instruments for measuring dielectric properties, insulation resistance, stress patterns, and noise, as well as a broad line of testing laboratory accessories.

Included will be a precision capacitance bridge, with guard circuit, generator, detector, and dielectric cell, for measure-

➡

First Line, l. to r.: Screw power testing machine; viscometer; foam rubber testing machine; X-ray industrial quantometer.
Second Line, l. to r.: Weatherometer; horizontal utility cabinet for environmental testing applications between −10 F and −95 F; X-Y recorder for plotting the physical characteristics of an electric motor.
Third Line, l. to r.: Twist tester; tintometer or comparator for comparing colors; radiographic X-ray equipment.
Fourth Line, l. to r.: Tensile tester; atmospheric control cabinet providing for testing of various products under different atmospheric conditions; and hardness tester.



ments at low frequencies; a slotted line and admittance meter for high frequencies, both direct-indicating and bridge-type instruments for the determination of insulation resistance; a sound-measuring system adaptable both to measuring the properties of acoustic materials and to the evaluation of deafness hazard in noisy environments; a polariscope for both static and dynamic stress evaluation; power sources and null detectors for bridge measurements of dielectric properties; and Variac adjustable autotransformers with stabilized brush tracks.

William J. Hacker & Co., Inc.
Booth 62

The new Reichert Metallograph to be exhibited by William J. Hacker & Co., Inc. includes the following features: Interference Tester for Surface Finish, Phase Contrast for Metallography, Micro-Hardness Tester, Scientific Vibration Control Device, etc.

Also to be shown is the new Micro-Viewscope for analysis of fibers. Here a microscope, a projector, and a screen are combined into one unit.

Another item to be shown for the first time is the Foam Rubber Testing Machine Model Z-140.

Hanovia Chemical & Manufacturing Co.
Booth 39

The Hanovia exhibit will include their line of mercury arc lamps, ultraviolet meters, and fused quartz prepared to ASTM Standards.

High Voltage Engineering Corp.
Booth 22

High Voltage Engineering Corp. manufactures Van de Graaff particle accelerators for science and industry. Of these, the most interesting to ASTM are the two-million-volt X-ray generator for precision radiography and the intense neutron source for activation analysis and production of radioactive isotopes. Featured at the HVEC booth will be a scale model of the two-million-volt radiographic X-ray unit. Technical experts will be on hand to describe the usefulness of Van de Graaff accelerators and to discuss application problems with ASTM members.

Hudson Bay Division, Refrigeration Systems, Inc.
Booth 48

The interior temperature of an air conditioned igloo will be the subject of a temperature estimating contest. The igloo—mechanically refrigerated to a sub-zero condition—will be available for examination by booth visitors. The display will also feature the actual use of a −95 F Horizontal Utility Cabinet for simulation of extreme temperature conditions in the test of materials and equipment.

Humboldt Manufacturing Co.
Booth 71

Many pieces of testing apparatus, most of which are in accordance with ASTM specifications will be on display, including a new Motor-Driven Flow Table, and an Acme Curing Can. In addition there will be a Ductility Testing Machine for Asphalt; a Penetrometer for Asphalt, Grease and Food Products; Flash Point Apparatus; Tar Stills; Cement and Concrete Specimen Molds; and Vicat-Gillmore Apparatus.

Instron Engineering Corp.
Booths 36 and 37

Instron will exhibit an instrument for indicating complete analysis of behavior under tension and compression through analysis of the detailed variations of the stress-strain curve, with time rigidly controlled.

The Instron Universal Testing Instrument measures and records elongation, relaxation, compression, and hysteresis to full scale loads of 2 g up to 5000 lb at speeds of 0.02 to 20 in. per min. This machine is claimed to open up new analytical possibilities in fields of plastics, rubber, textiles, wire, paper, leather, etc.

Jarrell-Ash Co.
Booth 43

A new spectrophotometer for use with volumes of 0.01–5 ml will be exhibited, a double-beam instrument for use in the ultraviolet and visible regions between approximately 200 and 700 mu. Examples of the use of the instrument in biochemical and histochemical research will be detailed.

A new console model microphotometer having reproducibility better than 0.5 per cent, scattered light not exceeding 0.7 per cent, linearity within 3 per cent, and a drift not to exceed 0.5 per cent in 15 minutes or better will also be described and shown.

King Refrigeration Co.
Booth 38

A Model 260 Cloud and Pour Test Cabinet will be displayed. This cabinet has four temperatures of +30 F, 0 F, −30 F, and −60 F. Each temperature has individual, hermetic, removable refrigeration units (four in all). The sleeves are weighted removable type for easier cleaning and drying. This cabinet also has a moisture-controlled, heated top so that moisture will not condense in humid weather.

Kocour Co.
Booth 49

Kocour will display the Electronic Thickness Tester, Model TT, for determining the thickness of silver, tin, cadmium, zinc, brass, copper, nickel, and lead deposits on various metallic and nonmetallic base materials. Tests are claimed to be accurate to within 90–95 per cent, and require about one minute to make... readings are direct from the counter on the instrument panel. The minimum thickness which can be determined is 2–3 hundred thousandths of an inch (2–3 millionths of an inch for chromium). The instrument operates at 105–125 volts, 60 cycles ac.

Labline, Inc.
Booths 44 and 45

On display will be Labline's new laboratory sectional furniture suitable for all types of industrial laboratories. Constant temperature circulating systems for refractometers, constant temperature utility baths for temperatures up to 212 F, and other special types of baths for temperatures up to 200 C will be shown. Included in their line of petroleum test apparatus will be mechanically refrigerated cloud and pour apparatus; oxygen gum apparatus; Reid vapor pressure; flash point testers, such as Pensky-Martens, Tags and Clevelands; oxygen stability apparatus for testing lubricating greases; universal penetrometer; and a new constant temperature Saybolt viscosimeter. Gas calorimeters and industrial ovens for temperatures up to 950 F and Labline's new "Force-Aire" Bench-Saver Ovens for temperatures up to 270 C will be an important part of the display.

Laboratory Equipment Corp.
Booth 54

Operating in the booth will be carbon and sulfur analysis apparatus for testing steel and cast iron samples. Visitors may participate by bringing samples of unknowns for carbon and sulfur analysis with an induction furnace.

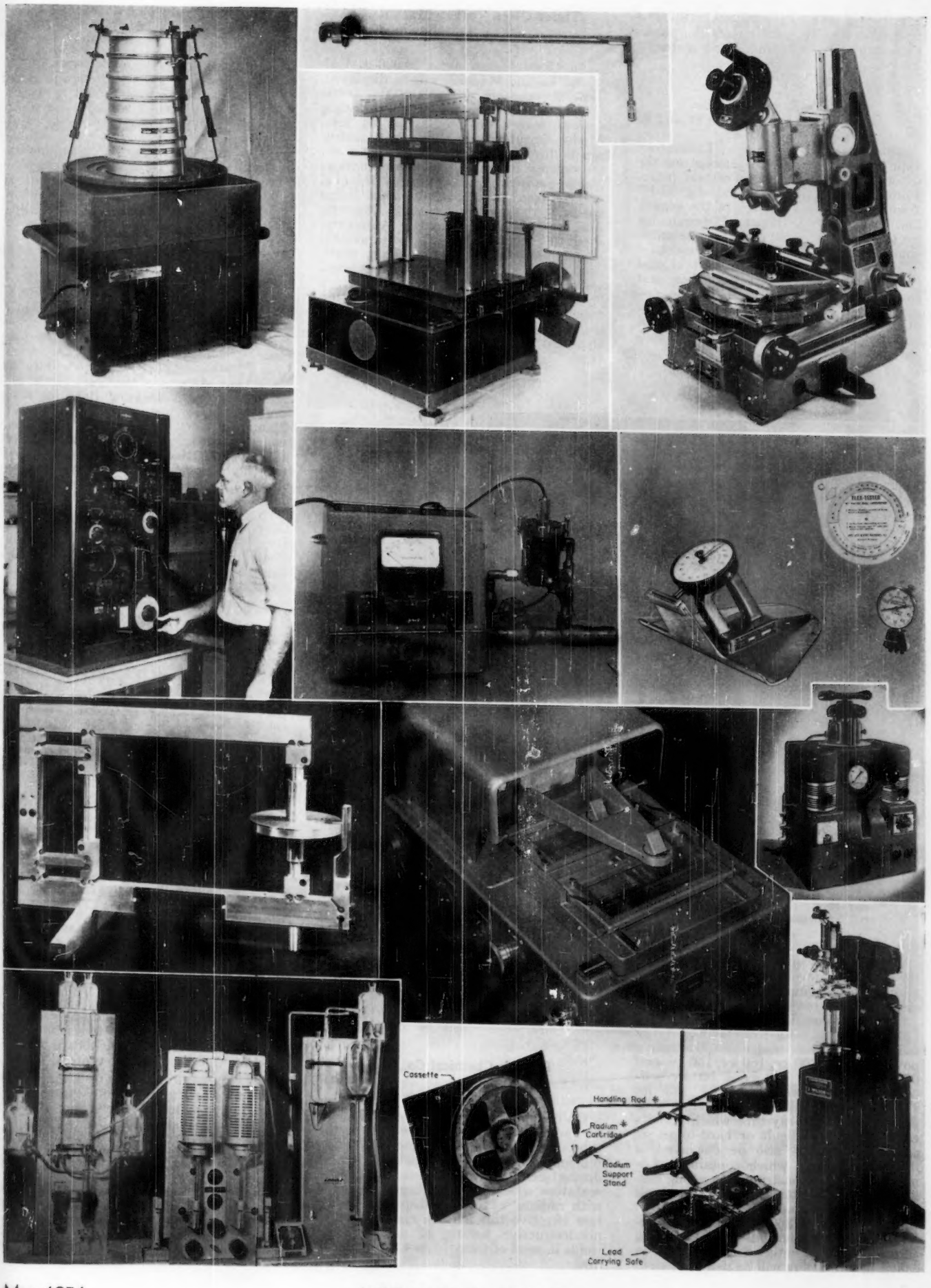
Arthur S. La Pine & Co.
Booth 29

The booth display will feature a new inexpensive sieve shaker, new type atom models, assorted petroleum testing apparatus, a plastics abrasion tester, specialty laboratory apparatus, and new and improved laboratory ware for general use. A new bath cooler will also be on display.

Leeds & Northrup Co.
Booths 15 and 16

Leeds & Northrup will have 3 operating demonstrations illustrating a few of the many types of precision analyses possible with L&N equipment: (1) The new Recording Spectrometer will demonstrate isotope-ratio analysis using hydrogen and deuterium. (2) The new Speedomax Polar recorder plots a function of "r" (radius) against a function of θ (angular

Top Center: Jointed industrial telescope for examining pipe welds utilizing a test hole a few inches distant from the weld.
First Line, l. to r.: Motor-driven vibrator designed for sieves from 6 to 16 in. in diameter; 1000 lb compression-crush tester for containers, wallboard, plastics, and paperboard; toolmakers' microscope.
Second Line, l. to r.: Capacitance measuring assembly for dielectric measurement of samples and conditioning chambers; water-in-oil meter; tester for sheet metal to determine its drawing qualities and stretcher-strain characteristics.
Third Line, l. to r.: Calibrator designed for precision checking of extensometers, strain gages, and dial gages; comparator densitometer for reading emission spectroscopy photographic densities directly on a linear scale; speed press.
Fourth Line, l. to r.: Two-station combustion unit with carbon and sulfur determinators; radium exposure set up; microhardness tester capable of applying loads down to 1 g using either the Knoop or the 136 deg diamond pyramid indenter.


Cassette
Handling Rod
Radium Cartridge
Radium Support Stand
Lead Carrying Safe

rotation of the chart paper). (3) The Speedomax X-Y recorder plots the physical characteristics of an electric motor.

Lindberg Engineering Co.
Booths 75 and 76

Lindberg Engineering Co., Laboratory Equipment Division, will demonstrate the determination of sulfur in certain petroleum products, using the Lindberg "H-F" Induction Unit for ignition of the sample and the Lindberg Sulfur Determinator for the titration measurement of the sulfur content of the products of combustion.

Methods of determining carbon and sulfur in metals, coals, and cokes, and some organic materials will also be displayed. Information regarding the many other products for laboratory, and pilot plant heating requirements will be available.

Magnaflux Corp.
Booth 78

Apparatus and equipment for nondestructive testing will be shown including Magnaflux, Zyglo, Sonizon, and others.

National Forge & Ordnance Co.
Booth 17

National Forge & Ordnance Co. will exhibit a 5000-lb Container Compression Tester along with a 1000-lb Compression-Crush Tester for containers, wallboard, plastics, and paperboard and the new Izod-Charpy Impact Tester for plastics, ceramics, and die-cast alloys. Also shown will be a Specimen Cutter and various tools for use with the machines.

National Spectrographic Sales Corp.
Booths 13 and 14

The latest combination of spectrographic laboratory equipment—spectrograph, microphotometer, and excitation—together with complete accessories for quantitative analysis will be shown.

North American Philips Co., Inc.
Booths 79 and 80

North American Philips will display their newly developed line of Radiographic X-ray equipment. The apparatus displayed has been designed particularly for use in Industrial Radiography and are not adaptations made from medical X-ray units. The units range in penetrating power through 300 kv, 160 kv, 150 kv, and 60 kv. Featured will be a 160-kv self-contained unit weighing only 143 lb. This unit is tanklike in construction with an end window X-ray tube which permits easy access to difficult or hard-to-get at areas. There will also be displayed, a novel X-ray tube which contains a 1.5-mm focus and is constructed in a long rod-like shape permitting entry into small openings. The radiation output from this tube is in a 360 degree radius permitting circumferential exposures. In addition a magnetic detection device called the Portoflux will be demonstrated.

Tinius Olsen Testing Machine Co.
Booths 30 and 31

An Olsen Electromatic 20,000-lb Universal Testing Machine will be displayed. Testing machine features 100:1 scale range with electronic weighing and loading system, speeds 0.05 to 20 in. per min, Model 51 Recorder, numerous instruments for the recorder and plastic extensometer R-20A designed for nonrigid plastic testing. The machine is provided with new automatic rate of strain device specially designed for testing titanium. Also to be shown are an Automatic Program Controller which will perform load stress cycling, strain cycling, crosshead cycling, production testing, proof testing, and yield strength testing; a "Super L" 60,000-lb Compression Testing machine adapted for testing concrete cylinders and cubes; and a Model 54 Hand-Operated Brinell Hardness testing machine.

Parr Instrument Co.
Booth 34

Five different oxygen bombs for calorimetry and combustion tests will be shown in the Parr exhibit. These include bombs for routine and precise calorimetry, bombs for testing explosives, and for micro combustions. An adiabatic calorimeter and various accessories for calorific tests of solid and liquid fuels will be shown. Other Parr equipment will include a stirrer-type apparatus with 1- and 2-liter stainless steel bombs for chemical reactions at pressures up to 1000 psi.

Precision Scientific Co.
Booths 67 and 68

The Precision Scientific Company display will feature redesigns of equipment already under ASTM specifications. They will display their Front View Distillation units with the new Lo-Cap Heater, their redesigned Pensky-Martens Flash Cup Testers, the Cleveland Open Cup, the redesigned Wet Test Meter, Bronze Block Gum Bath, Shell Roll Tester, Water Wash-out Grease Tester, Ramsbottom Carbon Residue. For Cement interest, the Cement Bleeding apparatus will be shown.

Radium Chemical Co., Inc.
Booth 7

On exhibit will be complete equipment for radium radiography. Included in the exhibit will be an electromagnetic handling rod for positioning of the radium capsule during setup of the exposure. A representative collection of radiographs made with radium will be on display to show how effective this method can be for the nondestructive testing of castings and welds in steel of from ½ to 4 in. in thickness.

Riehle Testing Machines Division American Machine and Metals Inc.
Booths 57 and 58

Riehle will display new equipment for determining how metal alloys will react during forming operations and in use at high temperatures. Testing machines can utilize electric furnaces producing temperatures to 2200 F and permits installation of multiple furnaces for production testing. Screw powered, this machine provides positive control of testing speed and maintains a constant rate of strain at any speed setting. Accommodates specimen diameters 0.252 to 0.505 in.

Scott Testers, Inc.
Booth 1

Scott Testers will show physical testing apparatus for elastomers, textiles, wire, and other materials. Featured will be the first public showing of the Scott Model LG Aluminum Block Heating Bath for temperature aging tests, an insulated solid aluminum block oven with 28 individual compartments. Also on display will be the Scott ORRL-6 tensile tester for rubber and high elongation materials; the recently developed "Accr-O-Meter" weighing system for constant rate of extension testing suitable for rubber testing; the Model E Brittle Point Tester with a capacity of 10 samples at a time; and the new Scott individual stainless steel pressure aging container for exposing small quantities of elastomeric specimens.

Service Diamond Tool Co.
Booth 72

The Service Diamond Tool Co. will display its "A" Hardness Testing Machine for both standards and superficial Rockwell testing. It is designed for accurate, efficient production testing, featuring recessed dial and nonglare light focused on work; conveniently grouped controls and standardized weights, all totally enclosed and chrome plated.

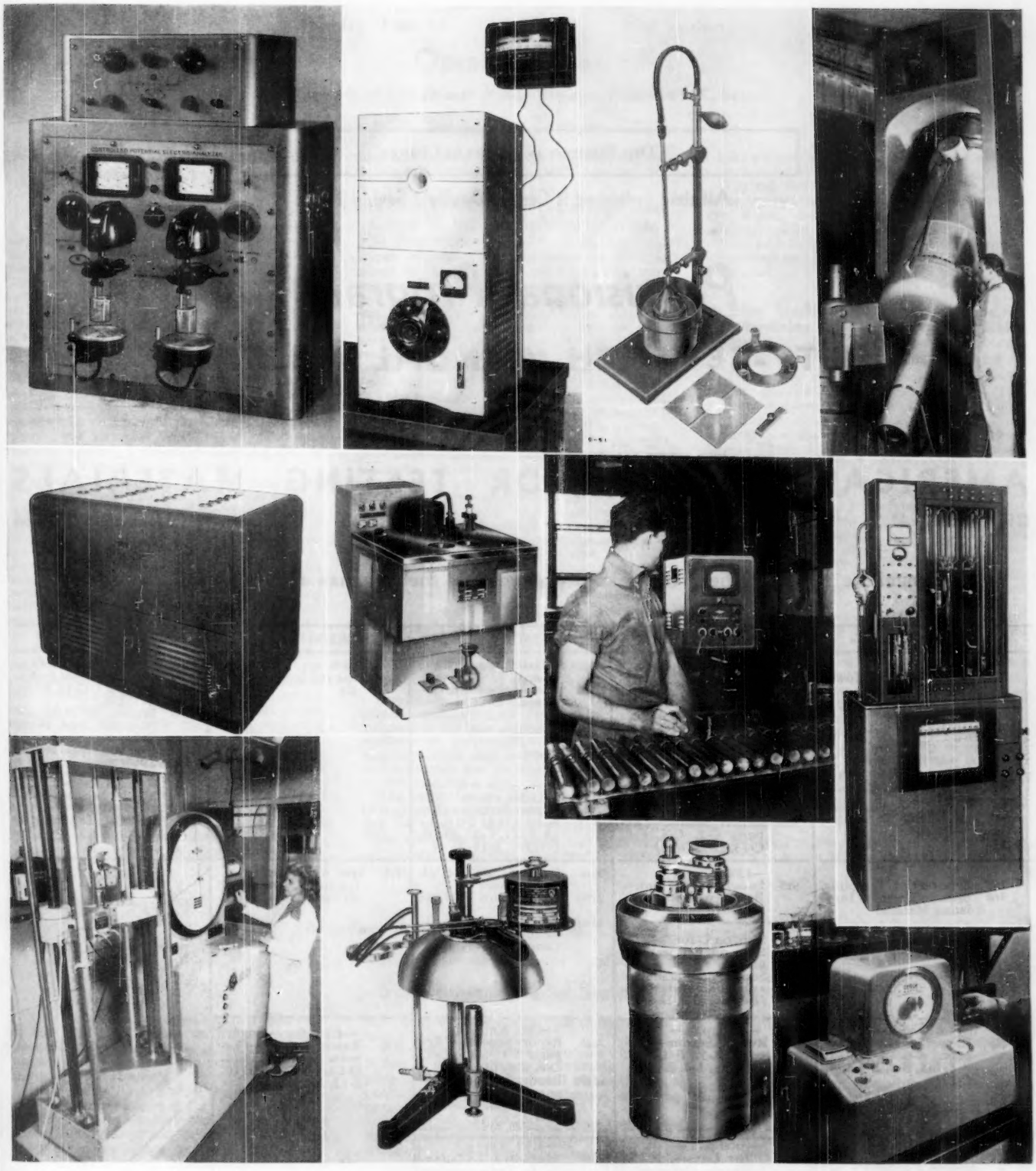
Sperry Products, Inc.
Booth 66

Sperry will exhibit two of its latest model ultrasonic reflectoscopes. The instruments will be operated in actual demonstration of inspection of raw materials and finished parts. The exhibit will also contain explanations of the various methods of testing with this instrument to meet requirements of different industries and applications. A large blackboard will be used for the discussion of visitors' testing problems.

Steel City Testing Machines, Inc.
Booth 28

Feature attraction in the booth will be the new Flex-Tester for testing sheet metal to determine its drawing qualities and stretcher-strain characteristics. De-

(Continued on page 50)



First Line, l. to r.: Control potential electro-analyzer for precise determinations of metals; platinum-wound electric furnace for high-temperature laboratory work; apparatus for testing cement bleeding. A model of this two million volt X-ray generator will be on display.
Second Line, l. to r.: Cloud and pour test cabinet; constant temperature Saybolt viscometer; ultrasonic reflectoscope; apparatus for the analysis of light hydrocarbons.
Third Line, l. to r.: 20,000 lb universal testing machine; Pensky-Martens flash tester, gas heated; self-sealing oxygen bomb for calorimetry and combustion; Beta ray H/C meter.

This Program is Subject to Change

All time indicated is Central Daylight Saving Time

Provisional Program

FIFTY-SEVENTH ANNUAL MEETING

of the

AMERICAN SOCIETY FOR TESTING MATERIALS

CHICAGO, ILL. **JUNE 13–18, 1954**

Committee Meetings held throughout the week at the Sherman and Morrison Hotels

	MONDAY, June 14	TUESDAY, June 15	WEDNESDAY, June 16	THURSDAY, June 17	FRIDAY, June 18
Morning	—10:00 a.m.— *1st* Opening Session—Testing	*7th* Chicago Sponsored Session on Specifications	*18th* Session on Fatigue *(cont.)* *19th* Session on Soils—*(Report D-18)*	*27th* Sym. on Cyclic Heating and Stressing Metals	*33rd* Sym. on Building Constructions *(cont.)*—Reports C-7, C-19, C-20, D-7, E-6*)* *34th* Session on Plastics—*(Reports D-14, D-20, D-23)* *35th* Session on Impact Testing
		—11:30 a.m.— *8th* Report Session—*(Reports C-2, C-4, C-8, C-13, D-3, D-22)*	—11:30 a.m.— *20th* Report Session—*(Reports C-14, C-16, C-18, C-21, C-22, D-10, E-1, E-5, E-11*		—11:30 a.m.— *36th* Report Session—*(Reports A-3, C-9, C-12, D-2, D-8, D-15, D-19, D-21, E-12, Jt. Ef. Temp.)*
Afternoon	*2nd* Sym. on Coal Sampling *3rd* Sym. on Electrical Insulating Material	—12:00 noon— *9th* Luncheon Session—President's Address, Awards *10th* Sym. on Odor *11th* Sym. on Permeability of Soils *12th* Session on Bituminous and Road Materials—*(Reports D-4, D-16)*	*21st* Session on High Temperature *22nd* Session on Fatigue *(cont.)* *23rd* Session on Significance of Tests of Concrete	*28th* Sym. on Cyclic Heating and Stressing Metals *(cont.)*	
	—4:30 p.m.— *4th* Report Session—*(Reports A-6, A-7, B-1, B-4, B-5, B-8, B-9, C-3, C-17)*	—4:30 p.m.— *13th* Report Session—*(Reports A-5, B-2, B-7, D-5, E-3, E-4, E-9)*	—4:00 p.m.— *24th* Report Session—*(Reports C-1, C-11, D-1, D-6, D-9, D-17)* *25th* Report Session—*(Reports A-1, B-3, B-6, E-7, Adm. Comm. Corr.)*	—4:30 p.m.— *29th* Report Session—*(Reports A-2, A-10, D-11, D-12, D-13, E-2, E-10, E-13, E-14)*	
		—5:00 p.m.— *14th* Gillett Lecture, R. L. Templin—Aluminum	—4:30 p.m.— *26th* Marburg Lecture, H. E. Dodge—Interpretation of Data, Medal Awards		
Evening	*5th* Sym. on Coal Sampling *(cont.)* *6th* Sym. on Electrical Insulating Material *(cont.)*	*15th* Sym. on Odor *(cont.)* *16th* Session on Fatigue *17th* Sym. on Permeability of Soils *(cont.)*	Cocktail Party ASTM DINNER Floor Show Dancing	*30th* Session on Creep *31st* Session on Concrete *32nd* Sym. on Building Constructions	

ASTM Registration Desk opens Sunday June 13.

Monday, June 14 10:00 a.m. First Session

Opening Session

Formal Opening of Fifty-seventh Annual Meeting, President L. C. Beard

Session on Testing

Experiences in Low Load Hardness Testing. P. Grodzinski, Industrial Distributors (Sales) Ltd.

When work on the microhardness testing of hard materials, such as sintered carbide, silicon carbide, aluminum oxide, and diamond was started about 8 years ago, a Bergsman microhardness tester (up to 200 g load) was fitted to the available Vickers projection microscope using a Vickers diamond. Experience showed that on hard material only, with higher loads and a control independent of the operator, could reliable results be obtained. Subsequently a stronger Bergsman type hardness tester for loads up to 3000 g was devised and provided with an automatic control. The limitations of this hardness tester were later on avoided by an optical low load hardness tester in which the optical system was arranged at an angle to the mechanical system, a sensitive damping device controlling the indenting process.

In order to perform tests at various loads to find the real hardness properties of materials, the so-called Meyer analysis was used. Considerations with regard to the low load range led to a proposal to define hardness not as load divided by unrecovered indentation area, but express it as the load which causes a standard deformation in the material. This led to the design of a low load hardness tester in which the load is increased continuously, measuring at the same time the depth of indentation. By combining a mechanical loading device with pneumatic measurement of depth of indentation it was possible to record the load-depth of indentation characteristic in a diagram. A preload can be applied. Besides the load-depth curves also time-depth curves for studying creep and recovery processes can be plotted. In this way the elastic and plastic properties of a material can be recorded and the hardness test can be made to a true rheological test.

A durable indenter was found in the double cone diamond which is neither broken when in contact with hard surfaces, nor causes breakage of the indentations in brittle materials. Furthermore, it allows one to determine directional properties on cold-worked metals and crystalline materials.

Size Effect in the Tension Test of Mild Steel. Cedric W. Richards, Stanford University.

In 1931 Fujio Nakanishi made his well-known report of a yield point in bending raised by 50 per cent above that in tension, using rectangular beams of mild steel. The presence of a size effect seems to offer the only satisfactory explanation for this and subsequent widely divergent results that have been reported over the past twenty-odd years. The investigations described herein has for its objects the development of an adequate theoretical basis for such a size effect and the testing of its validity by experiment. Due to a similarity between the discontinuous yielding of mild steel and brittle fracture, Weibull's Statistical Theory of the Strength of Materials has been adapted to fit the new problem. On account of its statistical nature large numbers of tests are required to check the theory. The present report covers the first series of tests, which were made in tension. The experimental results obtained demonstrate a definite dependence of the upper yield point of mild steel on specimen size. Thus the conclusion is reached that in the tension test of mild steel the specimen size is one of the important variables.

Production Testing of Bonded Materials with Ultrasonics—A Survey of Theory and Application. G. B. Baumeister, Magnaflux Corp.

One of the biggest drawbacks to the widespread application of bonded materials in industry is the lack of an effective economical method of inspection. Given a suitable bonding inspection method, new processes and materials can be used to produce better products at less cost.

The reflection or absorption of ultrasonic energy at the interface of bonded materials can be used to indicate the lack of bond. Data are given to correlate such parameters as crystal diameter, frequency, material thickness, and acoustic properties with extent of unbonded area.

Typical industrial applications of ultrasonic equipment for lack of bond detection are given. Semiautomatic operation and innovations in the detection equipment are discussed which result in more positive quality control and lower cost even with unskilled personnel.

A New Triaxial Stress Testing Machine for Determining Plastic Stress-Strain Relations. H. A. B. Wiseman and Joseph Marin, The Pennsylvania State University.

This paper describes a new machine for testing metals under triaxial stresses. The stresses applied consist of two equal compressive principal stresses with the third principal stress either tension or compression. These triaxial stresses are produced by subjecting a cylindrical specimen to radial hydraulic pressure and axial tension or compression. By means of these triaxial stress tests mechanical properties of materials under various states of triaxial stresses can be obtained and triaxial plastic stress-strain relations can be determined. These tests also serve to check further the validity of plasticity theories used to predict plastic stress-strain relations under combined stresses.

This paper also describes a preliminary investigation dealing with plastic stress-strain relations for an aluminum alloy 14S-T6 subjected to the triaxial state of stress described. The tests were conducted for a constant ratio of the principal stresses, but the influence of different ratios of the axial stress to the radial compressive stress on the plastic stress-strain relations was investigated. The test results show that the simple flow theory of plasticity using the second stress invariant is in approximate agreement with the test results.

E-4 on Metallography. L. L. Wyman, Chairman.

Fourth Progress Report of Subcommittee XI on Electron Microstructure of Steel.

Monday, June 14 2:00 p.m. Second Session

Held simultaneously with the Third Session

Symposium on Coal Sampling

This two-session symposium is a follow-up of the 1951 Symposium on Bulk Sampling, devoted to coal sampling only. Considerable emphasis is placed on the mechanical sampling of coal in motion.

Four papers dealing with theory and background will be followed by three papers describing and evaluating the performance of three different types of mechanical coal samplers in use in large power plants.

R. C. Tomlinson, Mathematician of the National Coal Board of Great Britian, and Jan Visman, formerly of the Dutch State Mines, will participate in the program. International participation in a symposium of this type is unusual, and having two men of their ability added to an excellent panel makes this a rare event.

The Development of the Theoretical Basis of Coal Sampling. W. M. Bertholf, Colorado Fuel and Iron Corp.

This paper is a review of the two main lines of investigation which proceeded the over-all attack of the problem of coal sampling by L. A. Bushell in 1937, in which it is shown that the "simple" experiment fails to disclose the true nature of the problem.

Use of the techniques introduced by R. A. Fisher, *et al.*, permits us to evaluate the sampling constants of a coal, and we are then in a position to formulate a satisfactory sampling procedure.

Certain simplifications of these techniques will permit the accumulation of variance data without undue expense. The methods of Visman, Tanner, and Deming and those currently in use in Britain are compared.

Some Recent British Work on Coal Sampling. R. C. Tomlinson, National Coal Board.

This paper describes some of the work on coal sampling, both theoretical and experimental, carried out in the United Kingdom during the last two years. One of the features of the work has been the extensive use of the method of duplicate sampling whereby it is possible to measure the sampling accuracy without the necessity for a complicated special experiment. Work has also been done to measure the errors arising in the preparation of the sample for analysis and it has been found that these errors are large enough to cause concern when aiming for high accuracy. Finally, the application of these results to the revision of a sampling specification is discussed.

Multi-Lot Sampling, the Accuracies in Sampling of Large Coal Shipments by Application of the Variance Concept. R. A. Miskimen and R. S. Thurston, American Gas and Electric Service Corp.

This paper presents a system for applying the variance concept of coal sampling to routine sampling work. The relation between the design of routine sampling schemes and the resulting accuracy can be found by evaluating the "observed" variance of the coal and the combined variance of sample reduction and analysis. These accuracies can be expressed with regard to large quantities of coal consisting of many "lots," or barges, or rail cars, rather than merely for one "lot" as in the existing ASTM specifications.

(Continued in Fifth Session)

Monday, June 14 2:00 p.m. Third Session

Held simultaneously with the Second Session

Symposium on Temperature Stability of Electrical Insulating Materials

For many years, insulating materials have been divided into several temperature classes defined to a large extent on a broad definition of their composition, that is, organic, inorganic, combinations of organic and inorganic, etc. Service experience over many years has served generally to confirm the classifications and to establish the suggested temperature limits for each class.

However, during the years the classes and the temperatures associated with them have in some cases become too restrictive in view of the rapid development of new insulating materials. It has therefore become increasingly apparent that insulating technology can no longer wait for the confirmation of heat stability but service experience alone. Test methods must be developed and accepted which also can serve as guides in this respect. This first ASTM Symposium on Temperature Stability of Electrical Insulating Materials is an important part of such effort. The papers, of course, represent only the opinion and experiences of the individual authors except where otherwise stated. Active work is under way to develop generally accepted standards for determining the thermal stability of insulating materials.

Measurements of Dielectric Properties at Temperatures Up to 500 C. A. H. Scott, P. Ehrlich, J. F. Richardson, National Bureau of Standards.

A holder for dielectric specimens is described which can be used over a temperature range from room temperature to 500 C and over a frequency range from 10^2 to 10^7 cycles per sec. Provision is made for measuring the thermal expansion of the sample. The dielectric constant can be determined with a probable error not exceeding about 1 per cent and the dissipation factor with a probable error not exceeding about 0.0001 or 5 per cent whichever is greater for the lower frequencies and about 0.0015 or 5 per cent whichever is greater at 10 mc per sec. Illustrative data on boron nitride and alumina body are given.

Dielectric Measurements on Plastics at High Temperatures. Thomas Hazen, Bakelite Corp.

Typical data illustrating the dielectric behavior of several representative commercial plastics, including phenolics, silicones, polyesters, epoxy resins, and polymonochlorotrifluoroethylene, at elevated temperatures are presented in graphical form. The temperature range covered by the measurements was between 23 and 200 C, the upper limit depending upon material type.

Somewhat limited information concerning the effect of relatively long exposures to high temperatures on the electrical properties of phenolic-glass laminates, silicone laminates, and molding materials, and polymonochlorotrifluoroethylene is given.

The experimental procedures and equipment used for dielectric measurements on plastics at high temperatures are discussed briefly.

Electrical Resistivity of Bonded Micaceous Materials at Elevated Temperature. K. Wechsler, Mica Insulator Co.

Electrical insulating plate made of inorganic bonded mica splittings has a long satisfactory history as heater conductor insulation in applications requiring relatively little mechanical support for the insulation. Nevertheless, standard test methods for determining the quality of this material are singularly lacking, as are specifications prescribing acceptable quality levels for the material as such. The purpose of this paper is to describe a test method for the determination of the volume and surface resistivities, measured at the extreme temperature normally associated with the use of inorganic bonded muscovite heater plate. The test method is intended to provide for a convenient means of measurement suitable for use as an acceptance test and for manufacturing control, with the degree of accuracy and precision necessary to distinguish between quality levels of heater plate and to produce satisfactory agreement between various laboratories as to the quality levels.

(Continued in Sixth Session)

Test Methods for Studying Thermal Stability and Heat Aging of Insulating Varnish. A. H. Haroldson, Continental Diamond Fibre Co.

Thermal Stability of Insulating Fabrics. R. C. Bartlett, Natvar Corp.

As a result of a survey of the members of Subcommittee VII on Insulating Fabrics of ASTM Committee D-9 on Electrical Insulating materials suggestions, opinions, and test data on thermal stability of electrical insulation have been assembled. Insulating materials within the scope of this survey are coated glass fabrics, varnished cloth, coated sleeving, and elastomeric adhesive tapes. This collection represents the efforts of most of the members of Subcommittee VII and is designed to present their composite point of view on thermal stability. Change in dielectric strength (ASTM D 902), change in thickness, change in weight, cut-through characteristics, and static modulus of elasticity are tests discussed as means of evaluating the effect of elevated temperatures on insulating fabrics and elastomeric tapes. Several new test methods are described and presented for future consideration in ASTM activities.

Monday, June 14 4:30 p.m. Fourth Session

Committee Report Session

A-6 on Magnetic Properties. R. L. Sanford, Chairman

A-7 on Malleable-Iron Castings. W. A. Kennedy, Chairman.

B-1 on Wires for Electrical Conductors. D Halloran, Chairman.

B-4 on Electrical Heating, Resistance, and Related Alloys. S. A. Standing, Chairman.

B-5 on Copper and Copper Alloys, Cast and Wrought. G. H. Harnden, Chairman.

B-8 on Electrodeposited Metallic Coatings. C. H. Sample, Chairman.

B-9 on Metal Powders and Metal Powder Products. F. V. Lenel, Chairman.

C-3 on Chemical-Resistant Mortars. Beaumont Thomas, Chairman.

C-17 on Asbestos-Cement Products. D. Wolochow, Chairman.

Monday, June 14 8:00 p.m. Fifth Session

Held simultaneously with the Sixth Session

Symposium on Coal Sampling *(Continued)*

A Test on a Slotted Revolving Cylinder Coal Sampler. A. O. Blatter, Union Electric Co. of Missouri.

The paper presents the procedure and results of a test performed on an automatic coal sampler which uses a slotted cylinder for the sampling instrument. A comparison of per cent ash, size consist, and sample weights obtained, is made with hand samples taken at similar locations from the conveyor belt ahead of the sampler. Substantial variations in average size consists and weights of samples were found. The average ash percentage for the eleven tests performed was found to be 13.8 for the automatic sampler and 13.5 for the hand samples.

Tests of Accuracy of a Mechanical Coal Sampler. R. L. Coryell, F. J. Schwerd, and E. J. Parente, Consolidated Edison Co. of New York.

A program for testing accuracy of an established mechanical coal sampling procedure is described and applied. Each step in the sampling procedure was tested for presence of bias and no significant bias was found. Sampling tests were made on a lot of mixed coals totaling 13,600 tons and the results analyzed for variances. For these coals, it is shown statistically that the ASTM accuracy required for commercial coal sampling may be obtained for any size lot by taking the number of increments (50 lb each) required by the ASTM procedure for lots of less than 1000 tons. However, to obtain the ASTM "special purpose" sampling accuracies, a single gross sample of these coals will not suffice.

Test of the Geary-Jennings Sampler at Cabin Creek. W. M. Bertholf, Colorado Fuel & Iron Corp., and W. L. Webb, American Gas & Electric Service Corp.

This paper presents the results of a thorough test of all phases of the mechanical sampling system at the Cabin Creek Plant of the American Gas and Electric Service Corp.

Testing of the sampling system itself is described in two of the sections of the paper—others are concerned with determining the variability of the coal and the variation introduced by the reduction and analysis of the equivalent of gross samples for an 8-hr shift.

It is concluded that the mechanical sampling of this coal may be made as precise as is desired, and the ultimate limits of accuracy will be those of the process of reduction and analysis of the samples.

The Variances of Reduction and Analysis. W. W. Anderson, Commercial Testing and Engineering Co., and M. L. Sutherland, Statistical Consultant.

The equations of variance applicable to coal sampling can be solved only by substituting known values for each component of variance in the equations. The accuracy of analysis for dry ash content of coal is one contributing source of variation in the multiple system of variations which contribute complexity to a clear-cut solution of the coal sampling problem.

This paper gives experimental data on the phase of the problem which embraces the variances associated with the reduction and analysis of the gross sample of coal after it has been collected. Variance values are included for each stage of the standard ASTM procedure for reduction and analysis as specified in Tentative Method D 271–51 T.

The data indicate several points in the present procedure where systematic variations occur. Calculations of the magnitude of these systematic variations disclose the potential reduction in the variances of reduction and analysis if such systematic variations could be eliminated from the standard methods.

Monday, June 14 8:00 p.m. Sixth Session

Held simultaneously with the Fifth Session

Symposium on Temperature Stability of Electrical Insulating Materials *(Continued)*

Thermal Stability of Polyvinyl Chloride Insulating Compounds. R. C. Bartlett, Natvar Corp.

With the objective of more accurately evaluating thermal stability of flexible polyvinyl chloride electrical insulation, a new test method and procedure for using test data therefrom are given. How static modulus of elasticity of PVC insulation baked at elevated temperatures can demonstrate thermal decay is shown with test data. By interpretation of mechanical tests thus obtained, an index of thermal stability for any given PVC compound can be obtained. This index can be employed to make predictions of the useful mechanical life of such PVC insulation up to periods of 25 years. Since electrical insulation can fail mechanically before its electrical properties have deteriorated to an objectionably low level, this approach to the problem may be useful for design of electrical apparatus and specifying quality of material.

The Deflected Beam Film Rupture Test Applied to Sheet Insulation. K. N. Mathes and H. I. Morgan, General Electric Co.

This paper discusses the application of the deflected beam film rupture technique for the determination of the heat resistance of sheet and tape insulation such as is used in motor and generator insulation.

The sample employed makes use of a taped structure impregnated with insulating varnish in a manner similar to the conditions involved in actual equipment. The test procedure measures the elongation of the surface of the sample in transverse bending required to cause cracking or discontinuity as indicated by electrical failure. A comparison of varnished cloth with synthetic sheet insulation is made.

The method proposed is believed to be a functional technique which may be used for temperature classifications of such insulating materials by test.

A Method for Evaluation of the Thermal Aging Stability of Flexible Sheet Insulation. C. G. Currin and R. M. Plettner, Dow Corning Corp.

A method for evaluating the thermal aging stability of flexible sheet insulation has been developed using the dielectric strength of the insulation as the failure criterion. This test method has been designed for functional and statistical accuracy, simplicity, and economy of time, labor, materials, and equipment.

Samples of flexible sheet insulation are aged at elevated temperatures. After periods of aging, the samples are subjected to a dielectric stress in an electrode system which elongates the sheet insulation approximately 1 per cent. The time required for average dielectric strength to drop to a predetermined level is the life of the insulating material. By testing at several temperatures, the life-temperature relationship is established over a temperature range. This relationship is the goal of the test and from it the life at lower temperatures may be predicted.

Preliminary experience has shown this test method satisfies the design goals.

Aging of Silicone Treated Glass Cloth. O. E. Anderson, Continental Diamond Fibre Co.

Heat Aging Characteristics of Insulating Varnishes. H. I. Morgan and K. N. Mathes, General Electric Co.

This paper describes the use of the deflected beam film rupture test for evaluating the heat resistance of magnet wire insulation with different types of insulating varnish. The degree of elongation of the surface to cause cracking or discontinuity as indicated by electrical failure is measured.

Results for conventional as well as modified silicone varnishes will be compared after exposure for increasing periods of time at high temperatures.

This technique is proposed as a functional test method for determining the temperature classifications of insulating varnishes when used as impregnates for magnet wire and similar insulation structures.

Tuesday, June 15 9:30 a.m. Seventh Session

Significance of Specifications—Current Thoughts on Materials Standards

Introduction and Background—R. J. Painter, Executive Secretary, ASTM.

Specifications from the Consumers Viewpoint—A. W. F. Green, Chief Metallurgist, Allison Div., General Motors Corp., Indianapolis, Ind.

Specifications from the Producers Viewpoint—A. O. Schaefer, Vice-President in Charge of Engineering and Manufacturing, The Midvale Co., Nicetown, Philadelphia, Pa.

Materials Standards and the Department of Defense—Roger F. Hepenstal, Director, Cataloging, Standardization and Inspection, and Capt. C. R. Watts, Staff Director, Standardization, Office of Assistant Secretary of Defense (Supply and Logistics).

Tuesday, June 15 11:30 a.m. Eighth Session

Committee Report Session

C-2 on Magnesium Oxychloride and Magnesium Oxysulfate Cements.

C-4 on Clay Pipe. J. C. Riedel, Chairman.

C-8 on Refractories. R. B. Sosman, Chairman.

C-13 on Concrete Pipe. R. R. Litehiser, Chairman.

D-3 on Gaseous Fuels. A. W. Gauger, Chairman.

D-22 on Methods of Atmospheric Sampling and Analysis. L. C. McCabe, Chairman.

Tuesday, June 15 12:00 noon Ninth Session

Luncheon Session—President's Address, 40- and 50-Year Members, Awards of Merit, Introduction of New Officers

Tuesday, June 15 2:30 p.m. Tenth Session

Held simultaneously with the Eleventh and Twelfth Sessions

Symposium on Odor

Although odor is an important property of materials, it has suffered to some degree from lack of attention because workers in the field have not reached agreement on objectives or methods of analysis, or even on definitions of basic terms. Commercial methods of control or modification of odors have likewise received only sporadic critical evaluation.

This symposium will therefore deal with those practical aspects of odor involving definitions, analytical methods, and control. The seven papers to be presented should provide a critical summary of the present status of odor technology and help point the way to further progress.

Odor: A Proposal for Some Basic Definitions. Edward Sagarin, Standard Aromatics, Inc.

The author points out that there has been no serious effort to define odor, and proposes a definition based upon the exclusion of other sensations and upon awareness of the stimulus by the observer. Inasmuch as awareness may exist in some individuals and not others, when they are subjected to contact with the volatile particles of a given substance, such a substance would be considered odorless for some and odorous for others. Odor is a quality that exists by virtue of a relationship between the stimulus and the perceiver, and is not inherent as a property of a substance. It is relative, rather than absolute, and is dependent, for purposes of scientific descriptive terminology, upon consensus.

A New Catalyst for Atmospheric Analysis and Control. R. J. Ruff, Catalytic Combustion Corp.

A new catalyst for oxidation of volatile organic matter at relatively low temperatures, consisting of platinum group metals on a nickel-chromium alloy carrier, has been developed and put into industrial use for prevention of atmospheric pollution and for heat recovery from air streams containing combustible matter in concentrations less than the lower limit of flammability. It is adaptable for use in testing and control instruments. A portable and a fixed instrument are described. Both are designed for measurement of concentrations of combustible matter above trace levels, such as occur in industrial equipment when solvents are evaporated. The catalyst and appurtenances are rugged and exhibit much less drift in continuous service than platinum-filament bridge instruments. Condensation in sampling lines is minimized by drawing streams in the order of 5 to 10 cu ft per min through short lines. Results are indicated in terms of temperature rise in the sample stream, which may be converted to thermal energy per unit volume, or to concentration if calibration is made.

(Continued in the Fifteenth Session)

Accurate Measurement of the Intensity of Odors. Louis Barail, Consulting Biochemist-Toxicologist.

The paper describes a method and an apparatus called the Osmagraph, which makes possible the reduction of organoleptic errors to a minimum. As the microscope permits the measurement of living or inert matters which are invisible to the naked eye, the Osmagraph permits the measurement of the intensity of odors which the human nose alone cannot accomplish. Most variations are eliminated or greatly reduced and trained technicians obtain on the same sample of odor, measurements which do not vary more than 4 to 5 per cent.

The author describes the applications of his method and the uses of his instrument in various industrial fields and gives examples of the intensity of various odors so evaluated.

Tuesday, June 15 2:30 p.m. Eleventh Session

Held simultaneously with the Tenth and Twelfth Sessions

Symposium on Permeability of Soils

Flow of water through soils has been much tested and studied theoretically. Despite the apparent simplicity of permeability tests, the rate of flow is affected by so many variables that divergent results are often obtained for apparently duplicate samples and there are often large differences between laboratory and field measurements. This symposium includes discussions of terminology, surface chemistry, structure, field and laboratory test methods and results, and a selected bibliography which should be helpful in developing standard test procedures.

Fluid Permeation Terminology. C. E. Jacob, Brigham Young University.

Controlled Test Methods in Permeability Testing and Interpretation of Test Data. Donald M. Burmister, Columbia University.

In making permeability tests primary consideration should be given to the use of the test data, since the use will determine the kind of test to be made. A wide range and variety of problems of the flow of water through soils are encountered in soil and foundation work. Different approaches, test conditions, and techniques necessarily are required in order to provide significant and basic data for investigating and solving these problems. There are certain fundamental principles to be applied in permeability testing, which are general in their scope, character, and application. But of greater importance with regard to the effective use of the test data are the test conditions, which must be carefully set up to "fit" the natural environmental conditions and to reflect properly the changes in conditions imposed by the construction of structures, where per-

meability and flow of water are governing physical factors in the situation. The principal testing problems in determining the permeability of soils are those of making observations and measurements under conditions reasonably similar to those to which the soils are actually to be subjected in soil and foundation work. Proper interpretation and evaluation of the test data are essential to the effective use of the test data in practical problems in order fully to bracket the possibilities in a situation. The basic approach is to particularize each situation so that it is possible to make predictions that are in closer agreement with the actual observed phenomena. The permeability testing of soils and the interpretation and use of test data are illustrated by practical examples.

Water Movement Through Porous Hydrophilic Systems Under Capillary, Electric and Thermal Potentials. Hans F. Winterkorn, Princeton University.

Permeability Test for Sands. T. Y. Chu and D. T. Davidson, Iowa State College.

This paper presents the development of a test method to determine the permeability of sands. The method, which is a modification of Barber's falling head permeability test, is simple to use and gives reproducible results.

In developing the test method, experiments were made for the following purposes: (1) to evaluate different methods of loading the sample in the permeameter, (2) to determine the effect of soaking the loaded sample in water for varying periods of time prior to testing, and (3) to compare test results for samples in which the entrapped air has or has not been removed.

(Continued in Seventeenth Session)

The test method developed was used to measure the permeability of several sands at different densities. The mineralogical composition and other properties of the sands are used to explain differences in permeability values.

Low-Head Permeameter for Granular Materials. E. G. Yemington, Bureau of Public Roads.

This paper describes the apparatus and method of test for measuring the permeability of granular materials using a small hydraulic gradient.

Test results on different types of material using different methods of testing are shown to indicate variances where turbulence and loss of fines are known factors.

Tuesday, June 15 2:30 p.m. Twelfth Session

Held simultaneously with the Tenth and Eleventh Sessions

Session on Bituminous Materials

Evaluating the Specific Gravity of Aggregates for Use in Bituminous Mixtures. W. C. Ricketts, J. C. Sprague, D. D. Tabb, and J. L. McRae, Corps of Engineers.

Because aggregates absorb bitumen to a variable extent no single one of the conventional specific gravities has proved satisfactory for general use with porous aggregates in bituminous mixtures. It is indicated that the proper specific gravity to use ranges from simulated conventional bulk to simulated conventional apparent, its relative numerical value depending upon the quantity and type pores and other characteristics of the aggregate that control the extent to which it is penetrated by bitumen. An erroneous aggregate specific gravity can cause a bituminous mix to be too lean or too rich, with attendant unsatisfactory characteristics.

This paper describes what is termed bulk impregnated specific gravity which is a function of, and is concomitantly proportional to, the ratio of bitumen to water absorption of an aggregate. This new specific gravity is an outgrowth of development of the Corps of Engineers' procedures for the design and control of bituminous paving mixtures and has been found satisfactory for general use with aggregates used in this connection.

A Simple Fractional Distillation Test for Creosote. H. L. Stasse, Barrett Div., Allied Chemicals & Dye Corp.

A simple distillation test for determination of the true boiling characteristics of creosote oil is presented. The apparatus is a modification of that used in the ASTM Standard Method of Test for Distillation of Creosote; a round-bottom flask fitted to a 5-ball distillation column is used in place of the standard flask.

Distillation data were obtained on creosotes of varying distillation characteristics using the standard test and the 5-ball column test. Comparison of these data with composition according to boiling points as obtained by careful fractionation, indicates that at temperatures of 315 C and below, results by the 5-ball column method agree closely with data obtained by fractionation, whereas results by the standard test have little significance as an indication of true boiling characteristics.

Report of Committee D-4 on Road and Paving Materials. C. A. Carpenter, Chairman.

Report of Committee D-16 on Industrial Aromatic Hydrocarbons and Related Materials. D. F. Gould, Chairman.

Tuesday, June 15 4:30 p.m. Thirteenth Session

Committee Report Session

A-5 on Corrosion of Iron and Steel. A. P. Jahn, Chairman.

B-2 on Non-Ferrous Metals and Alloys. B. W. Gonser, Chairman.

B-7 on Light Metals and Alloys, Cast and Wrought. I. V. Williams, Chairman.

D-5 on Coal and Coke. W. W. Anderson, Chairman.

E-3 on Chemical Analysis of Metals. J. W. Stillman, Chairman.

E-9 on Fatigue. R. E. Peterson, Chairman.

Tuesday, June 15 5:00 p.m. Fourteenth Session

Gillett Memorial Lecture

Fatigue of Aluminum. R. L. Templin, Director of Research and Engineer of Tests, Aluminum Company of America.

This Lecture, established in 1951, is jointly sponsored by ASTM with Battelle Memorial Institute. It commemorates Horace W. Gillett, one of America's leading technologists and metallurgists and the first Director of Battelle. The Lecture is delivered annually at a meeting of the Society, the first one having been given at the Fiftieth Anniversary Meeting, June, 1952. The Lecture will cover subjects pertaining to the development, testing, evaluation, and application of metals.

Tuesday, June 15 8:00 p.m. Fifteenth Session

Held simultaneously with the Sixteeth and Seventeenth Sessions

Symposium on Odor (*Continued*)

The Design, Construction, and Use of an Odor Test Room. Nicholas Deininger and Russell W. McKinley, Arthur D. Little, Inc.

A 500-cu ft test room has been designed, constructed, and used for the study of odorants in a variety of carriers. The basic design of the test room is functional and adaptable, permitting the necessary auxiliary equipment to be removed and rearranged as desired. The room is planned to be odor-free and nonadsorptive. Construction materials have been selected to provide optimum odor-testing conditions at the lowest cost in keeping with this goal. Odor-testing in the room has been conducted according to the Odor Profile method administered by a panel of trained odor chemists.

Organoleptic Appraisal of Three-Component Mixtures. A. Haldane Gee, Foster D. Snell, Inc.

The methods were developed under a United States Air Force contract in connection with the control of undesirable odors in hospital aircraft, without masking alarm or signal odors indicative of mechanical trouble or of an incipient fire on the airplane.

The components of cabin air are (1) odors of infected wounds and of body discharges, (2) odor control agents, (3) vapors and smokes from gasoline, hot lubricating oil and hydraulic fluid, burning electrical insulation, and scorching paint. These were appraised in experimental mixtures by the use of profile scoring. Plotting the results showed the effects of the control agents.

The malodors were partly masked by essential oils. Ozone canceled the malodors but must be used with care. Smokes and other alarm odors were unaffected by the control agents.

Odor Pollution from an Official's Viewpoint. C. W. Gruber, City of Cincinnati.

This paper deals with the problems of outdoor pollution faced by the air-pollution control official. Following a general presentation of the problem, several case histories of malodor situations and the success or failure of the odor correction applied are given.

The survey of an area to develop the citizen reaction to the odor pollution situation and a procedure developed by the Bureau of Smoke Inspection to monitor the odor level of a rather wide area will be described. Generalized specifications for the requirements of outdoor odor pollution monitoring by an air pollution enforcement office will be included.

Odor Control Methods: A Critical Review. Amos Turk, Consulting Chemist.

Commercial methods of odor control (other than removal of the source) now available, include (*a*) combustion with or without the aid of catalysts, (*b*) sorption by activated carbon, sometimes with chemisorption, (*c*) washing or scrubbing methods, (*d*) odor neutralization, and (*e*) odor masking. Each of these methods is critically evaluated from the viewpoints of the technical and economic limiting factors in its application.

This paper therefore considers the heating costs in catalytic combustion as a function of process variables, the service life between reactivations for carbon in different atmospheres, the efficiency of scrubbing methods, the reduction of odor intensity by neutralization, and the acceptability of masking methods.

Tuesday, June 15 8:00 p.m. Sixteenth Session

Held simultaneously with the Fifteenth and Seventeenth Sessions

Session on Fatigue

Softening of Certain Cold Worked Metals Under the Action of Fatigue Loads. N. H. Polakowski, Armzen Co., and A. Palchoudhuri, The Small Tools Manufacturing Co. of India Ltd.

There is a widespread belief that failure of a ductile metal by fatigue is invariably associated with progressive strain-hardening. The present work indicates, however, that this is not always so.

Compression and hardness tests on fatigued specimens of copper, nickel and aluminum and three of their alloys, and of a titanium-killed low-carbon steel showed that fatigue stressing above the endurance limit produced work-hardening effects only when the materials were initially annealed. With the same metals in the cold-drawn condition, fatigue resulted in a distinct softening in each case.

An analysis of these results led to the conclusion that the above phenomena could have been anticipated on general grounds.

It thus appears that various theories of fatigue which incorporate the "extreme work-hardening" concept in one or another form are, in fact, based upon a plausible but not generally true assumption.

Metallographic Aspects of Fatigue Behavior of Aluminum. M. S. Hunter and W. G. Fricke, Jr., Aluminum Company of America.

Several methods are described for detecting and following changes in surface features which take place during a fatigue test. In aluminum alloys, these changes are initially of submicroscopic magnitude but, as the test progresses, they become progressively more pronounced until final, complete failure. It is shown that the cycles of stress required to produce certain well-defined changes are related to the fatigue life. The relationship between curves of progressive damage determined by these methods and the well-known *S-N* curve is shown for several aluminum alloys.

The Influence of Test Temperature and Grain Size on the Fatigue Notch Sensitivity of "Refractaloy-26." P. R. Toolin, Westinghouse Electric Corp.

An investigation of the fatigue notch sensitivity of "Refractaloy-26" was made over the temperature range from room temperature to 1500 F. Refractaloy-26 is a precipitation hardened, wrought alloy developed for high-temperature service. The investigation was carried out with completely reversed stress, repeated bending tests. It was found that, rather than being greatest at room temperature, the notch sensitivity, q, of this alloy reaches a maximum at an elevated temperature. The data also permit comparison of the notch sensitivities of fine and coarse-grained material and an estimation of the temperatures for equal fatigue strengths for unnotched specimens and for notched specimens having these structures. In all cases the fatigue strength reduction factors were less than the theoretical elastic stress concentration factor.

An Experimental Study of the Influence of Fluctuating Stress Amplitude on Fatigue Life of 75S-T6 Aluminum. H. T. Corten, G. M. Sinclair, and T. J. Dolan, University of Illinois.

A study was made of the influence of fluctuating stress amplitude on the fatigue life of 75S-T6 aluminum. The pattern of fluctuating stress consisted of repeated blocks of 10,000 cycles during which a minor or low stress amplitude was applied during the initial portion and a major or high stress amplitude was applied during the remainder of the cycles in each repeated block. Various major and minor stresses as well as various per cents of cycles at the major stress were employed. Nine series of data, each consisting of 20 specimens, were collected. The data were analyzed statistically to obtain values of mean fatigue life and standard deviation of known reliability. It was shown that the life for fluctuating stress amplitude may be best correlated with the life at the major stress (constant amplitude). When the major stress was applied for only 5 per cent of the cycles in each block, an unexpectedly long life resulted.

(Continued in the Eighteenth and Twenty-second Sessions)

Tuesday, June 15 8:00 p.m. Seventeenth Session

Held simultaneously with the Fifteenth and Sixteenth Sessions

Symposium on Permeability of Soils (*Continued*)

The Permeability of Compacted Fine Grained Soils. T. W. Lambe, Massachusetts Institute of Technology.

The placing of fill material at its minimum permeability is usually desirable in the construction of such water retaining structures as dams, reservoirs, and canals. The measurement of the permeability of fine grain soils and the determination of the compaction conditions to obtain the minimum permeability can be, therefore, an important job of the soils engineer.

This paper describes a simple apparatus for measuring the permeability of low-permeability soils. It employs a sample container equal in size to the Wilson Miniature Compaction mold. A sample is compacted in the mold and then subjected to a permeability test. A plot of compacted density and permeability *versus* molding water content can be made from the data taken.

Tests on several soils show that minimum permeability is usually obtained at a water content wetter than that (optimum water content) for maximum density. Samples compacted on the dry side of optimum often become less permeable and swell under continued flow.

The Permeability and Settlement of Laboratory Specimens of Sand and Sand-Gravel Mixtures. Chester W. Jones, Bureau of Reclamation.

The paper describes the procedure and presents the results of laboratory permeability-settlement tests on sand and sand-gravel mixtures. The tests include data on specimens containing 3-in., ¾-in., and No. 4 maximum particle sizes. Duplicate specimens were placed at three different relative densities and were subjected to four different loading pressures. Gravel contents ranged from 0 to 80 per cent.

The specimens with 20, 35, and 50 per cent gravel showed a much lower permeability than those with lower and higher gravel contents. Settlements were low and of secondary importance in the study. The tests show that for soils containing gravel, the gravel should be included in the laboratory specimen for a reasonably good determination of the permeability.

Measurement of the Hydraulic Conductivity of Soil, in Place. Don Kirkham, Iowa State College.

Several recently developed methods for the measurement of the hydraulic conductivity of soil, in place, are described. Data from these methods are presented and compared. Particular attention is given to the so-called auger hole and piezometer methods. In the auger-hole method an auger hole is bored to a depth below the water table and the water in it pumped out. After the hole has been emptied the ensuing rate of rise of water in it is determined and this rate then converted to the hydraulic conductivity of the soil by use of a suitable formula. In the piezometer method the procedure is the same except that the auger hole is now effectively cased, and there is only a small cavity at the base of the cased hole into which the rate of water entry is noted. The latter method has the advantage that it permits the measurement of the hydraulic conductivity at virtually a point in the soil. The auger hole method, on the other hand, gives an average conductivity for the whole length of the hole. Results from the auger hole method are less variable. The problem of soil anisotropy is discussed and it is shown how the anisotropic components of the hydraulic conductivity may be determined.

The Water Permeabilities of Soils and Sediments. W. O. Smith, Geological Survey.

This paper presents an account of certain physical conditions which must be considered in the measurement of permeabilities of soils and sediments. Among these are sediment structure, particularly whether the sample is disturbed or undisturbed, the occlusion of air, and finally the effects of colloidal material.

To better meet some of these conditions a special sampling procedure has been developed for the taking of undisturbed samples suitable for permeability measurement. The particular sampler is of the piston type, and contains an inner barrel, in which an undisturbed soil sample is taken. The inner barrel, with its undisturbed sample, is then wholly removable, and serves as the permeammeter tube in subsequent permeability measurements. The techniques for permeability measurement are described.

It is emphasized throughout the paper that if consistent results are to be obtained in permeability determinations, the test liquid must be one which is in equilibrium with the soil sample to be measured, as far as colloidal chemical properties are concerned. For example, in the determination of ground water permeabilities, actual ground water which is assumed to be in equilibrium with the sediments of the aquifer must be used. If fluids such as distilled water or ordinary laboratory tap water are used, then severe washing of colloidal material may occur, due to a change in the exchangeable ions, with a consequent erroneous measurement of the permeability. The effect arises from an alteration of the saturating base of the clay.

Finally, the alterations in permeability due to trapped air and other gaseous material are discussed. They result in a decreased value of permeability.

Wednesday, June 16 9:00 p.m. Eighteenth Session

Held simultaneously with the Nineteenth Session

Session on Fatigue (*Continued*)

Fatigue Strength of 14S-T4 Aluminum Alloy Subjected to Biaxial Stresses. Robert W. Bundy, E. I. du Pont de Nemours & Co., Inc., and J. Marin, The Pennsylvania State University.

The purpose of this investigation was to determine the influence of biaxial tension-tension and biaxial tension-compression stresses on the fatigue strength of a 14S-T4 aluminum alloy. The biaxial fatigue stresses were produced in a specially designed testing machine by subjecting a circular thin-wall tubular specimen simultaneously to pulsating internal pressure and fluctuating axial tension or compression. Various ratios of the biaxial stresses were investigated. The maximum and minimum biaxial stresses were kept in phase by adjusting the testing machine.

The test results show that the fatigue strength is greatly affected by the anisotropy of the material. Attempts are made in this paper to interpret the test results using theories of failure modified to provide for anisotropy.

A Failure Criterion for Multi-Axial Fatigue Stresses. F. B. Stulen and H. N. Cummings, Curtiss-Wright Corp.

A criterion or relation is developed for predicting fatigue failure in polycrystalline metals subjected to any combination of steady and vibratory multi-axial stresses. The criterion states that in the case of vibratory stresses in isotropic material the algebraically maximum principal stress, minus a certain constant, times the algebraically minimum principal stress, equals the endurance limit (or fatigue strength) of the metal. The theory, which is developed in detail, is founded on the assumption that failure is primarily associated with alternating slip on certain critical slip or shear planes and that the critical resolved shear stress governing failure is a linear function of the normal stresses on the critical planes. Methods are proposed to allow for the effect of anisotropy, also for the effect of steady stresses superimposed on the vibratory stresses.

Dynamic Creep and Rupture Properties of an Aluminum Alloy Under Axial Static and Fatigue Stress. F. W. DeMoney and B. J. Lazan, University of Minnesota.

Fatigue, stress-rupture, and creep data obtained under various combinations of mean and alternating axial stress are presented and discussed for rolled aluminum alloy 24-S-T4 at 300 and 500 F. The data are presented as S-N curves and stress range diagrams to show the effect of temperature, alternating-to-mean load ratio, and stress magnitude on the fatigue, stress-rupture, and creep properties.

(Continued in the Twenty-second Session)

The effect of temperature and alternating-to-mean ratio on the characteristics of the creep curve is discussed on on the basis of "static" and "dynamic" types.

The role of both creep and fatigue as factors in rupture is discussed with particular reference to temperature and alternating-to-mean ratio.

Experiments in Fatigue Under Ranges of Stress from Tension to Extreme Compression. W. N. Findley, University of Illinois.

Axial-load fatigue tests were performed on SAE 4340 steel at mean stresses from 40,000 psi in tension to 130,000 psi in compression (a stress equal to the tensile strength). Elaborate precautions were taken to insure axial loading of specimens. In the extreme compression tests the entire stress cycle was a compression stress of 20,000 psi or greater. This was done to determine whether fatigue cracks could form and propagate in a cycle containing no tensile stresses—even from residual stresses.

A technique for doubling the yield point in compression was also demonstrated and used in these fatigue tests. An experiment was also performed on 75 S-T aluminum alloy to determine whether the large effect of mean stress on the fatigue strength in tension and in torsion was due to the change in structure of the material resulting from inelastic action or to other causes.

Wednesday, June 16 9:00 p.m. Nineteenth Session

Held simultaneously with the Eighteenth Session

Session on Soils

Study and Development of Methods for Determining In-Place Density of Soils. Donald F. Griffin, University of Southern California.

In the study of measurements for determining the in-place densities of cohesionless soils the following methods were investigated: (*a*) self-curing liquid plastic injections to form solid volumes of soil; (*b*) wedge-shaped soil samples obtained by inserting thin metal plates through guides into the soil; (*c*) cylindrical-shaped soil samples by using seamless brass tubes in connection with plaster-of-Paris caps; (*d*) quart jar sand funnel with supporting plate attached to a short tube; (*e*) large sand funnel with supporting plate; (*f*) large sand funnel with supporting plate attached to a tube; and (*g*) rubber-balloon apparatus with supporting plate attached to a tube.

All of the above methods involved a shearing action on the soil and therefore had the usual effect of causing loose sands to contract and tight sands to expand. A linear relationship between known or control density and the densities obtained by any test method was observed for all methods investigated. Certain methods showed less deviation from control density than did others. Moreover, each type of sand has its own straight-line formula for each test method.

Investigation of the Effect of Transient Loading on the Strength and Deformation Characteristics of Saturated Sands. H. B. Seed, University of California, and R. Lundgren, Woodward, Clyde and Associates.

The results of triaxial compression tests of the drained and undrained types, performed on saturated coarse and fine sands at various void ratios, using times of loading of about 10 min, 2 sec, and 0.02 sec are presented. The apparatus and testing techniques are briefly described. It is shown that for transient loading conditions the increase in strength of dense saturated sand is due partly to dilatancy and partly to the rate of loading; conclusions are drawn with regard to the magnitude of the latter effect. It is also shown that for relatively loose sands it is possible to discern a partial liquefaction condition in transient tests which is not indicated by undrained tests conducted at normal rates of loading.

Conclusions are also drawn regarding the effect of rate of loading on the modulus of deformation of saturated sands.

Piles Subjected to Lateral Thrust—Part I. H. G. Mason and J. A. Bishop, U. S. Naval Civil Engineering Research and Evaluation Lab.

Part I of the paper describes the test installation of a full scale investigation of the distribution of pressures and deflections along the length of an embedded pile when subjected to lateral loads. Details of the pile, gages used for pressure and deflection measurements, and the method of loading are presented. An example of the measured values of pressure and deflection is given and a comparison is made between them and the values obtained by the Palmer-Thompson theory. Two methods of solving the simultaneous difference equations employed in the computation of theoretical earth pressures, deflections, shears, and moments are introduced and an illustrative example is given.

Piles Subjected to Lateral Thrust—Part II. L. A. Palmer and P. P. Brown, Bureau of Yards and Docks.

Part II presents a brief background of the problems and shows the effects in variations of the parameters, n and k, on the distribution of earth pressures, deflections, moments, and shears with depth in the soil. A concise system of definitions of the difference equations is presented. The agreement between measured earth pressures and pile deflections with corresponding values computed from theory is made the basis for an analytical study of the effects of various factors such as the pile stiffness, the height of load application, and the pile width on the magnitude of the maximum bending moment and the depth at which it occurs.

Report of Committee D-18 on Soils for Engineering Purposes. E. J. Kilcawley, Chairman.

Wednesday, June 16 11:30 a.m. Twentieth Session

Committee Report Session

C-14 on Glass and Glass Products. L. G. Ghering, Chairman.

C-16 on Thermal Insulating Materials. E. R. Queer, Chairman.

C-18 on Natural Building Stones. L. W. Currier.

C-21 on Ceramic Whiteware. C. G. Harman, Chairman.

C-22 on Porcelain Enamel. W. N. Harrison, Chairman.

D-10 on Shipping Containers. G. E. Falkenau.

E-1 on Methods of Testing. J. R. Townsend, Chairman.

E-5 on Fire Tests of Materials and Constructions. A. L. Brown, Chairman.

E-11 on Quality Control of Materials. H. F. Dodge, Chairman.

Wednesday, June 16 2:00 p.m. Twenty-first Session

Held simultaneously with the Twenty-second and Twenty-third Sessions

Session on High Temperature

The Strength of Carbon Steels for Elevated Temperature Applications. R. F. Miller, United States Steel Corp.

The purpose of this investigation was to provide reliable information on the elevated temperature strength of present-day carbon steel plate and pipe, in the condition in which it is used in service, for the assistance of the Boiler Code Subcommittee in Evaluating the Allowable working stresses for such materials. The steels selected were made to the following ASTM Specifications: A 201, Grade B (Carbon-Silicon Steel Plates of Intermediate Tensile Ranges for Fusion Welded Boilers and Other Pressure Vessels), and A 106, Grade B (Seamless Carbon-Steel Pipe for High-Temperature Service). In order to study the effect of manufacturing practice, heats with high and low grain coarsening temperature (made with and without aluminum as a final deoxidizer) were included in the investigation. Elevated-temperature tension, creep, and rupture tests were carried out, and the grain coarsening characteristics were determined.

Statistical Evaluation of the Creep-Rupture Properties of Four Heat-Resistant Alloys in Sheet Form. A. I. Rush and J. W. Freeman, University of Michigan.

Stress-rupture tests were conducted on 10 heats each of four alloys, type 321, type 347, N 155, and Inconel X. The 10 heats represented material from several suppliers when possible, and were tested at three temperatures between 1200 and 1650 F for times out to 80 or 300 hr, depending upon the temperature and material. Total deformation strengths were determined for elongations of 0.2, 0.5, 1.0, and 2.0 per cent for time periods of 1, 5, 20, 80, and 300 hr, in so far as the data obtained from the rupture tests permitted.

Duplicate room-temperature tension tests were conducted on specimens selected from each heat to establish the variation in tensile properties within the sheet, as well as sheet-to-sheet variations.

All the stress rupture, total deformation, and tension test data were examined statistically to establish average values and the standard deviations where sufficient data were available.

No effort has been made to explain heat-to-heat variations in strength on the basis of metallurgical variables or to correlate tensile properties with stress-rupture properties.

High Temperature Sheet Fatigue. D. C. Goldberg and J. J. Lombardo, Westinghouse Electric Corp.

Authors present test data on a cantilever beam fatigue program carried out to evaluate the elevated temperature properties of several high-temperature sheet materials. *S-N* curves are reported on the following materials; L605, Discaloy, 19-9DL, Tinidur, Timken Alloy, V-36, and HS-88. In addition to the *S-N* curves, the test data, heat treatments, chemical analyses, and hardnesses of the materials before and after test are given. No attempt was made to analyze the significance of the results. This program is part of Project AP-2, Joint Committee on the Effect of Temperature on the Properties of Metals.

Thermal Shock Testing Procedure. E. W. F. Green, K. Lampson, and T. Tsareff, Allison Division, General Motors Corp.

Wednesday, June 16 2:00 p.m. Twenty-second Session

Held simultaneously with the Twenty-first and Twenty-third Sessions

Session on Fatigue (*Continued*)

A Simplified Statistical Procedure for Obtaining Design-Level Fatigue Curves. E. H. Schuette, The Dow Chemical Co.

The scatter inherent in most fatigue results makes multiple testing a "must" if suitable safe design stress levels are to be established. This same scatter, however, makes multiple testing an exceedingly tedious and time-consuming operation. The author suggests a procedure that will provide design-level curves with only a fraction of the testing time required for obtaining complete statistical data, and without mathematics. Illustrations of the method are provided by use of a large volume of simulated fatigue data, obtained in a novel manner.

An Appraisal of the Prot Method of Fatigue Testing. H. T. Corten, Todor Dimoff, and T. J. Dolan, University of Illinois.

The Prot progressively increasing load method of fatigue testing was investigated by comparing the experimental results for four ferrous metals and an aluminum alloy with conventional fatigue data. Both notched and unnotched specimens were studied. Two procedures were employed in analyzing the data. The first method makes use of the results of conventional fatigue data (obtained with constant stress amplitude) to evaluate an experimental constant required to obtain the optimum value of the endurance limit from the Prot data. The second procedure employs the general method of least squares and statistical analysis to obtain the optimum value of the endurance limit and an estimate of the statistical variation from only the data obtained with progressively increasing loads. The Prot method of fatigue testing appears most promising for rapid estimation of the endurance limit of ferrous metals.

Bureau of Aeronautics Investigations Concerning the Fatigue of Aircraft Structures. Robert A. Carl and Thomas J. Wegeng, Bureau of Aeronautics.

The loads imposed on the structures of combat military airplanes during maneuvering flight are sufficiently high to require consideration of the likelihood of a major fatigue failure occurring during the service life of the airplane. The Bureau of Aeronautics has sponsored laboratory investigations regarding the fatigue characteristics of three designs of naval airplanes during the past three years. S-N curves for certain major structural components of these airplanes have been determined and in one instance a modification was developed to increase the fatigue life of a wing structure. The results of an investigation of the cumulative damage effect of a spectrum loading on an aircraft outer wing panel are presented. An analysis of composite stress concentration factors present in several structural components is also included in this paper.

On Fatigue Tests Under Progressive Stress, a Theory of Fatigue of Metals and a Quick Method for Determining the Fatigue Limit. Nobusuke Enomoto, Railway Technical Laboratory, Japan. (To be presented by title only.)

Mild steel, aluminum alloy (duralumin), and brass have been tested by the Prot Method and the results have shown that there exist almost straight line relations between the stress at failure and a quarter power of the rate of stress increment, and the intersections of these lines with the stress axis have been verified to correspond nearly to the stress of fatigue limit. From the standpoint of internal lost energy needed for fatigue failure, the above relations have been derived theoretically from simple assumptions; as a result it is found to have a connection with *S-N* curve. The fatigue test under progressive stress has been ascertained to be effective as a quick way of determining the fatigue limit.

Wednesday, June 16 2:00 p.m. Twenty-third Session

Held simultaneously with the Twenty-first and Twenty-second Sessions

Session on Significance of Tests of Concrete

Mixing and Curing Water for Concrete. W. J. McCoy, Lehigh Portland Cement Co.

The quality of cements and aggregates is often exhaustively investigated but little attention is normally given to the requirements for the waters to be used with the cements and aggregates. Information is presented regarding the effects of waters containing various organic and inorganic compounds on the different properties of concrete such as rate of hardening, strength, durability, corrosion of reinforcement, and staining.

Procedures for evaluating the suitability of waters for mixing and curing concrete are discussed. From the data presented it can be concluded that the classical expression, "Water that is suitable for drinking is satisfactory for making concrete" is not always the best criterion.

Petrographic Examination of Concrete Aggregates. Richard C. Mielenz, Bureau of Reclamation.

The procedures and techniques of petrographic examination of concrete aggregate are described. Advantages, applications, and limitations of the methods are discussed and illustrated by field and laboratory experience.

Significance of Tests and Properties of Mineral Admixtures. H. S. Meissner, Bureau of Reclamation.

Powdered mineral admixtures frequently can be used in concrete mixes with advantage. As inert materials, they may improve the physical texture of the fresh concrete mix, imparting desirable characteristics to it or, when possessing pozzolanic properties, add to its final strength. However, the advent of air entrainment, with its marked effect on the workability of concrete, has in great measure displaced mineral admixtures as means for improving concrete mixes. Their contributions to concrete quality are more noticeable in lean mixes than in rich ones and are most marked when the concrete is deficient in fines. When pozzolanic, admixtures will improve impermeability, resistance to aggressive attack of sea water, sulfate bearing soil, and ground water, and to the attack of natural acid waters. They offer great advantage to mass concrete, lowering the heat of hydration and permitting the use of otherwise difficult, but desirable, lean mixes. Many mineral admixtures have also been shown to inhibit the reactive expansion found with some cement-aggregate combinations.

Air-Entraining Admixtures. C. E. Wuerpel, Marquette Cement Mfg. Co.

This paper is a review of the use of air entraining admixtures in mortars and concrete with especial reference to the significance of the tests made to evaluate the admixture and air entrained thereby.

Setting Time of Concrete. E. W. Scripture, Jr., The Master Builders Co.

This paper discusses suggestions for a definition of the setting time of concrete and attempts to arrive at a meaningful definition. Various suggested methods of testing concrete to determine its setting time are described. Reasons for eliminating certain of these methods from further consideration are given. Where data obtained by the various methods are available, examples are given. It is concluded that several test methods show promise but that the available data do not permit a definite selection. It seems probable that one test method will not satisfactorily determine the setting time of concrete for all types of mix and for all purposes.

Wednesday, June 16 4:00 p.m. Twenty-fourth Session

Held simultaneously with the Twenty-fifth Session

Committee Report Session

C-1 on Cement. R. R. Litehiser, Chairman.

C-11 on Gypsum.

C-15 on Manufactured Masonry Units. J. W. Whittemore, Chairman.

D-1 on Paint, Varnish, Lacquer, and Related Products. W. T. Pearce, Chairman.

D-6 on Paper and Paper Products. W. R. Willets, Chairman.

D-9 on Electrical Insulating Materials. A. H. Scott, Chairman.

D-17 on Naval Stores. V. E. Grotlisch, Chairman.

Wednesday, June 16 4:00 p.m. Twenty-fifth Session

Held simultaneously with the Twenty-fourth Session

Committee Report Session

A-1 on Steel. H. B. Oatley, Chairman.

B-3 on Corrosion of Non-Ferrous Metals and Alloys. Bruce W. Gonser, Chairman.

B-6 on Die-Cast Metals and Alloys. W. Babington, Chairman.

E-7 on Non-Destructive Testing. J. H. Bly, Chairman.

Advisory Committee on Corrosion. F. L. LaQue, Chairman.

Wednesday, June 16 4:30 p.m. Twenty-sixth Session

Marburg Lecture, Dudley Medal, and Awards

Marburg Lecture—Interpretation of Engineering Data. Harold F. Dodge, Quality Results Engineer, Bell Telephone Laboratories, and Chairman of Committee E-11 on Quality Control of Materials.

The purpose of the Edgar Marburg Lecture is to have described at the annual meetings of the Society, by leaders in their respective fields, outstanding developments in the promotion of knowledge of engineering materials. Established as a means of emphasizing the importance of the function of the Society of promoting knowledge of materials, the Lecture honors and perpetuates the memory of Edgar Marburg, first Secretary of the Society, who placed its work on a firm foundation and through his development of the technical programs brought wide recognition to the Society as a forum for the discussion of properties and tests of engineering materials.

Charles B. Dudley Medal
Richard L. Templin Award
Sam Tour Award

Wednesday, June 16

Cocktail Party 6:30 p.m.

ANNUAL DINNER 7:30 p.m.

Floor Show — Dancing 9:00 p.m. to 1:00 a.m.

Thursday, June 17 9:30 a.m. Twenty-seventh Session

Symposium on Effect of Cyclic Heating and Stressing on Metals at Elevated Temperatures

Eight papers will be given dealing with this subject. Two will cover various theoretical aspects including thermal stress fatigue and creep under intermittent load. Three papers will discuss creep and rupture data taken under intermittent load and temperature for various wrought bar and forging high-temperature alloys. Included will be both the so-called "stainless steels" as well as austenitic "super alloys" for gas turbine construction. Two papers will present intermittent load and temperature creep-rupture data for a number of alloys in sheet form. Both ferrous and non-ferrous alloys will be included here. Finally, a single paper will deal with the effect of cyclic temperatures on the scaling behavior of heat resisting alloys.

What We Need to Know About Creep. John E. Dorn and Lawrence A. Shepard, University of California.

A method of approach to the study of high-temperature creep is presented, in which the effects of the individual variables of temperature, stress, and the metal structure as affected by creep can be isolated and separately tested. Testing methods, results, and correlations for pure metals and dilute alloys are outlined, problems requiring further clarification discussed, and ways of extending the techniques for application in the study of complex alloy creep and creep at lower temperatures are suggested.

The Problem of Thermal Stress Fatigue in Austenitic Steels at Elevated Temperatures. L. F. Coffin, Jr., General Electric Co.

The localization of cyclic strain produced as a consequence of thermal fluctuations is principally responsible for thermal stress fatigue failures in structures fabricated from austenitic stainless steel. Mechanisms for strain localization are discussed, and experiments are reported for specimens designed to exhibit such localizations. Relationships between plastic strain change and cycles-to-failure are developed from tests performed on uniform specimens subjected to both cyclic strain at constant temperature and constrained cyclic thermal strain. These relationships are used to predict failure for the localized strain experiments. A difference in stress change and in cycles-to-failure between strain and constrained thermal cycling is observed.

(Continued in the Twenty-eighth Session)

The Effect of Temperature Cycling on the Rupture Strength of Some High Temperature Alloys. J. Miller, General Electric Co.

Cyclic temperature rupture tests were conducted on four different high-temperature alloys (S816, M252, 16-25-6, and A-286). Specimens were subjected to a constant load and three different types of temperature cycles. The size of the specimens and the method of heating was such that thermal stresses were considered to be negligible. The results of the tests are compared with calculated rupture lives made using constant temperature rupture data and integrating the life expenditure over a complete temperature cycle. The calculated and actual test values correlate very well although in general the actual values are somewhat lower than the calculated values.

Experiments on the Effects of Temperature and Load Changes on Creep-Rupture of Steels. G. V. Smith and E. G. Houston, U. S. Steel Corp.

Variation in stress or temperature during creep-to-rupture tests may result in alteration of the creep rate, or time to rupture, under certain conditions; it does not appear possible, however, to generalize regarding these changes, on the basis of the relatively few results now available.

Thursday, June 17 2:00 p.m. Twenty-eighth Session

Symposium on Effect of Cyclic Heating and Stressing on Metals at Elevated Temperatures (*Continued*)

Effects of Cyclic Overloads on the Creep Rates and Rupture Life of Inconel at 1700 F and 1800 F. R. H. Caughey and W. B. Hoyt, M. W. Kellogg Co.

A series of creep-rupture tests was conducted at 1700 and 1800 F on coarse-grain Inconel to determine the effect of cyclic mechanical and thermal overloads. The overloads were applied for a single continuous time interval and also for several cyclic time intervals of equal total duration. It was found that both mechanical and thermal cycling reduce rupture strength and increase creep rates. Thermal cycling appears to have the greater effect; also, it appears that multiple applications of the same load are of greater severity than the single load application.

The Creep-Rupture Properties of Aircraft Sheet Alloys Subjected to Intermittent Load and Temperature. G. J. Guarnieri, Cornell Aeronautical Lab., Inc.

The high-temperature creep-rupture properties of six sheet alloys having application to aircraft design were investigated under conditions of intermittent load and temperature for comparison with their corresponding constant temperature-constant load behavior. Included are type 321 stainless steel at 1200 and 1350 F, N-155 alloy at 1350 and 1500 F, Inconel X at 1350 and 1500 F, RC-130-A titanium at 800 F, 24S-T3 Alclad aluminum at 300, 450, and 600F, and FS-1H magnesium at 300 and 450 F.

Intermittent load-constant temperature tests were conducted with a cycle of 1-hr-load-on, 1-hr-load-off in most cases although several of the alloys were subjected also to an 8-hr-on, 8-hr-off load cycle. Intermittent temperature-constant load tests were made using a 2-hr cycle with the specimen at temperature 1 hr and cooled 1 hr. While these relatively simple cyclic conditions do not duplicate the complex load and temperature patterns encountered in aircraft service, the results obtained do provide some qualitative guidance in applying available static creep-rupture data to design of aircraft structural parts.

A wide variety of effects were produced by the intermittent load and temperature conditions. Stability of microstructure was one of the more significant variables controlling the alloy response to the cyclic conditions. Acceleration of creep and rupture was induced by intermittent loading where such processes as overaging, relaxation, recrystallization, and loss of ductility occurred. Retarding of creep and rupture occurred in those alloys where increase in ductility and creep recovery developed because of the intermittent-load cycle. Intermittent heating produced acceleration of creep and rupture in a number of cases, particularly where susceptibility to intergranular oxidation and cracking were aggravated by thermal stresses.

Constant and Cyclic-Stress Creep Tests of Several Sheet Materials. Ward F. Simmons and Howard C. Cross, Battelle Memorial Institute.

This investigation was made to determine whether alternate periods of load and rest have the same effect as continuous loading on creep of metals at elevated temperatures.

Constant-stress and cyclic-stress creep tests were made on sheet specimens of 24S-T3 and 24S-T81 aluminum alloys at 300 F, SAE 4130 steel at 800 F, and AISI 310 stainless steel at 1500 F. The test results indicate that cycling the load did not increase the creep rate of the materials tested. Specimens of 24S-T3 showed less creep during the first 10 hr of the tests than did the tests of 24S-T81 alloy, although subsequent creep rates were essentially the same.

The data indicate that it is probably safe to design for cyclic-stress conditions using data from constant-stress tests.

The Effect of Cyclic Temperature on the Scaling Behavior of Heat-Resisting Alloys. H. E. Eiselstein, International Nickel Co., Inc.

Thursday, June 17 4:30 p.m. Twenty-ninth Session

Committee Report Session

A-2 on Wrought Iron. A. D. Morris, Chairman.

A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys. Jerome Strauss, Chairman.

D-11 on Rubber and Rubber-Like Materials. Simon Collier, Chairman.

D-12 on Soaps and Other Detergents. J. C. Harris, Chairman.

D-13 on Textile Materials. W. D. Appel, Chairman.

E-2 on Emission Spectroscopy. B. F. Scribner, Chairman.

E-10 on Radioactive Isotopes. D. M. McCutcheon, Chairman.

E-13 on Absorption Spectroscopy. E. J. Rosenbaum, Chairman.

E-14 on Mass Spectrometry. W. S. Young, Chairman.

Thursday, June 17 8:00 p.m. Thirtieth Session

Held simultaneously with the Thirty-first and Thirty-second Sessions

Session on Creep

The Creep Characteristics of Copper-Nickel Alloys at 300, 400, and 500 F. J. H. Port and A. I. Blank, Chase Brass & Copper Co.

The creep characteristics of several copper-nickel alloys were determined at 300, 400, and 500 F. At these temperatures the creep strength of annealed 90–10 copper-nickel alloy containing 1.08 per cent iron is two or more times that of 90–10 copper-nickel alloy containing 0.68 per cent iron. For the annealed condition there is no significant difference at 300 F in the creep strengths of the higher iron-bearing 90–10 copper-nickel, the 80–20 copper-nickel of low iron content, and the 70–30 copper-nickel of low iron content. At 500 F the creep strengths of the 80–20 and the 70–30 alloys are still very similar but both are considerably higher than that of the annealed 90–10 copper-nickel alloy containing 1.08 per cent iron. The results also showed that the creep strength of the higher iron-bearing 90–10 copper-nickel alloy can be significantly improved by cold drawing 21 per cent.

Creep Properties of Annealed Unalloyed Zirconium. M. J. Manjoine and W. L. Mudge, Jr., Westinghouse Electric Corp.

The creep properties of unalloyed zirconium are critically dependent on the state of anneal. An equation is developed from fundamental considerations which expresses the plastic strain as a function of the stress, temperature, and time. This equation is similar to that proposed by McVetty; the creep rate conforms to the hyperbolic sine law suggested by Nadai; and the temperature-dependent coefficient follows the reaction rate theory as described by Kauzmann.

Tensile and Creep Properties at Elevated Temperatures of Some Magnesium-Base Wrought Alloys. Hugh Baker, The Dow Chemical Co.

This paper makes available to the designer properties of commercial magnesium-base wrought alloys at elevated temperatures. The following alloys are discussed: extruded FS1-F, M-F, and J1-F; rolled Sheet FS1-O, FS1-H24, M-O, and M-H24.

The tensile properties at elevated temperatures are compared. Results of creep tests for various times up to 256 hr, temperatures up to 500 F, and amounts up to 2 per cent total extension are also presented.

Tensile and Creep Properties at Elevated Temperatures of Some Magnesium-Base Sand Casting Alloys. K. E. Nelson, The Dow Chemical Co.

The tensile properties of several magnesium sand-casting alloys are compared at room temperature and at elevated temperatures as a function of time of exposure at elevated temperatures. Results of creep tests for various times, temperatures, and amounts of extensions up to 1 per cent are also presented. The alloys compared are: Dowmetal C-T6, ZK51A-T5, EK30A-T6, EK41A-T5, EK41A-T6, EZ33A-T5, HK31XA-T6, and HZ32XA-T5.

Thursday, June 17 8:00 p.m. Thirty-first Session

Held simultaneously with the Thirtieth and Thirty-second Sessions

Session on Concrete, Cementitious Materials

Investigations Relating to the Use of Fly Ash as a Pozzolan and as an Admixture in Portland Cement Concrete. L. John Minnick, G. & W. H. Corson, Inc. (To Be Presented by Title Only)

This report summarizes the results of a number of investigations on the use of fly ash as a pozzolanic material and as an admixture in portland cement concrete. The studies were also designed to develop information on numerous technical questions that had been raised by ASTM members.

The report includes round-robin tests which were set up to assist in the evaluation of specifications and methods of tests being considered by ASTM committees. In addition, various independent studies are reported which were carried out by ASTM members and other test engineers. The report also includes information taken from a comprehensive compilation of data that were submitted by the author in June, 1948, to ASTM Committees C-1 on Cement, C-9 on Concrete and Concrete Aggregates, C-12 on Mortars for Unit Masonry, C-13 on Concrete Pipe, and C-15 on Manufactured Masonry Units.

Some Observations on the Mechanics of Alkali-Aggregate Reaction. L. S. Brown, Portland Cement Assn.

Common procedure in the examination of a distressed concrete structure is to study the pattern of dislocation or failure in an effort to locate and identify the causative stresses. Potential causes of distress are numerous, and it is necessary to utilize the displacement pattern to determine which particular one may be implicated.

Occasionally the pattern of distress observed in the field examination has indicated a gross expansion of the concrete. While this indicates even further existence of some abnormal secondary mineralogic or chemical change within the concrete, the field examination often fails to reveal the nature of the constitutional change. Resort then is had to the microscope. Features of combined evidence of secondary alteration and associated displacement as observed in a variety of concretes will be presented in this paper, mostly by photograph. In this presentation only construction date and geographical locality will be given, there being no point in identification or description of the different structures.

Statistical Relation Between Cylinder, Modified Cube and Beam Strength of Concrete. Clyde E. Kesler, University of Illinois.

This paper attempts to determine statistically the relation between cylinder, modified cube, and beam strength of plain concrete. The results presented are based on over 1400 individual static strength tests involving concrete of different strengths and ages. All specimens, representing any one point on the graphs presented, were cast from a single batch of concrete.

The beams, having 6 by 6-in. cross-sections, were tested on two different span lengths, 18 and 60 in., and all with third point loading. The beams tested on the 18-in. span were portions of the beams tested on the 60-in. span. The modified cube tests were run on the broken pieces obtained from the beams tested on the 18-in. span. The cylinders tested were standard 6 by 12-in. cylinders.

This paper points out that the modulus of rupture may vary from 12 to about 20 per cent of the compressive strength as determined by the standard cylinder. It also indicates that the modified cube test gives a higher compressive strength, by 10 to 15 per cent, than the standard cylinder. Other comparisons are made.

All graphs have been fitted with "least squares" curves and for each curve the coefficient of correlation and the standard error of estimate are given.

A Rapid Accelerated Test for Cement-Aggregate Reaction. C. H. Scholar and G. M. Smith, Kansas State College.

This paper describes an accelerated method of test for predicting the deterioration of concrete caused by cement-aggregate reaction. A period of 90 days from time of casting specimens, is sufficient to discriminate between concretes with undesirable expansion and those of little or no expansion. The expansion data from the rapid accelerated exposure, referred to here as exposure 10, show a very good correlation with the expansion of concretes subjected to the well-known wetting and drying exposure, referred to here as exposure 2.

To substantiate the merit of exposure 10, data are presented showing the close correlation between the relative expansion of concretes subjected to 7.5 years of outside weathering and concretes subjected to exposure 2.

Cement-aggregate reaction as referred to in this paper is not restricted to the alkali-aggregate reaction, but refers to the physical and perhaps chemical reactions or a combination of both which cause the expansion that is usually accompanied by "map cracking." This type of cracking should not be confused with surface checking, shrinkage cracking, or cracking due to settlement and loads.

Cracking in Masonry Caused by Moisture Expansion of Structure Clay Tile. J. W. McBurney, National Bureau of Standards.

It is well known that certain fired clay bodies will, in time, slowly increase in volume through the interaction of water with the body. This effect, known as "moisture expansion," is recognized as one of the causes of cracking and crazing of glazed brick and tile. This paper describes several cases of severe cracking of masonry built in part with structural clay tile and, from laboratory tests of the various masonry materials together with elimination of other possible causes, establishes moisture expansion as the cause. Methods of test for existing moisture expansion and for possible future expansion are described in considerable detail.

Some Volume Changes in Mortar and Concrete. F. O. Anderegg and J. A. Anderegg, Anderegg Labs.

This paper consists of three parts: autoclave expansion of neat cements and Masonry; sand grading and shrinkage in mortar and concrete; and moisture movement in concrete made from cement blends. A brick pier was built using a normal hydrated dolomitic lime in the mortar, and the expansion and construction were observed over an extended period. A series of masonry cements, including one made from portland cement and raw mix; three based on natural cements; and three made from a hydraulic lime; was observed in autoclave expansion. These cements were used to construct piers, one being built out of doors, one inside, and the third next to a wall.

Tests using eight different sands, both commercial and specially graded, were run, in which mortar and concrete bars were made with different consistencies. Shrinkage was noted over a period of weeks, with evidence being found that the presence of a considerable amount of fines in the sands tended to increase the movement. Movements in the concrete were less than in the mortars.

Concrete was made using portland cement blended with a natural cement, hydraulic lime, raw mix, and fly ash, in varying ratios. Cement factors were varied for both dry and wet mixes. The blending did not seem to result in very significant differences in the moisture movements.

Thursday, June 17 8:00 p.m. Thirty-second Session

Held simultaneously with the Thirtieth and Thirty-first Sessions

Symposium on Methods of Testing Building Constructions

Impetus for this symposium was the apparent need for directing attention at this time to the present status of development in the fields of building research and the development of methods for evaluating building construction. It is hoped that this summary of current status will suffice to stimulate research work in areas which have hitherto been neglected. To this end the symposium attempts to define in part some of the neglected areas. The summary nature of the program justifies a broader scope than should ordinarily be attempted at once. Future symposiums based on work stimulated by this effort rightly should be restricted to more detailed development of smaller areas of interest.

Why Test Building Constructions. H. L. Whittemore, Mechanical Engineer

Structural Performance Requirements in Housing Codes. Lyman W. Wood, Forest Products Laboratory.

Housing performance requirements based on structural test methods are a modern development that is already well standardized and is beginning to appear in modern building codes. At the same time, performance requirements for housing are known to have been in existence several thousand years ago. So-called "specification codes" are often interpreted by "alternative-methods" provisions that are performance requirements, while "performance codes" are usually supplemented by an advisory portion of specification nature. Both types are thus combined in most codes. Code writers and building officials are doing a commendable job of allowing progress in the building arts while safeguarding public health and safety.

Transverse Tests of Masonry Walls. C. B. Monk, Jr., Structural Clay Products.

Using plastic bags with a restraining framework, uniform transverse loads were applied

(Continued in the Thirty-third Session)

to 8-ft-high walls of three 18 by 22-ft model structures. The walls represented three types of masonry construction: 6-in. brick, 4-in. brick with 4-in. concrete block, and 10-in. brick cavity. Window and door openings were provided, typical of modern ranch-type housing.

Results of the above field tests are compared with laboratory tests on standard 4 by 8-ft wall specimens. A statistical approach to working loads based on small numbers of large-scale samples is suggested. This approach emphasizes the importance of the number of specimens and the method of loading upon the resultant safety factor.

Fire Tests of Building Structures and Building Materials and Their Utilization in Building Code Requirements. A. J. Steiner, Underwriters Laboratories.

Friday, June 18 9:00 a.m. Thirty-third Session

Held simultaneously with the Thirty-fourth and Thirty-fifth Sessions

Symposium on Methods of Testing Building Constructions (*Continued*)

History and Bibliography of Wood Diaphragm Tests. A. C. Horner, Consulting Engineer.

Data are presented covering reports on early recorded research and test programs on wood sheathed diaphragms. The first of these tests cover full size floor or roof panels, with panel deflections being recorded and analysis made of the results as they might be applied to a building having brick walls braced by wood floors if subjected to an earthquake of a certain intensity.

Subsequent tests are reported on horizontal diaphragms made to 1/4 scale and a series of tests for developing fundamental data on the tensile and shearing strengths of metal joist anchors in masonry walls. In 1948 and 1949 independent series of tests are reported made on 1/4 scale models of single models of single-diagonally sheathed diaphragms corresponding roughly to customary roof construction. The 1949 tests had for their objective the development of further fundamental data on both vertical and horizontal elements subjected to loads applied in the plane of the diaphragm.

Glued and Nailed Roof Trusses for House Construction. R. F. Luxford, Forest Products Laboratory.

Lightweight nailed trusses have been used in house construction for a number of years with apparently satisfactory results. The performance of glued trusses has not been definitely established. A well-made glue joint when tested immediately after the glue has taken a permanent set is several times as strong as a well-nailed joint. After a glued truss has gone through several years of service the resultant unequal shrinking and swelling of the component parts of each joint may or may not weaken the truss.

Tests have been made on nailed and on glued trusses shortly after manufacture and after being subjected to two cycles of low and high humidities.

Lateral Tests on Full-Scale Lumber- and Plywood-Sheathed Roof Diaphragms. J. R. Stillinger, Oregon Forest Products Laboratory.

Nine 20- by 60-ft full-scale lumber- and plywood-sheathed roof diaphragms were built and tested at the Oregon Forest Products Laboratory during the Summers of 1952 and 1953. The primary objective of these testing programs was to evaluate the strength and stiffness in roof diaphragms resulting from the use of different sheathing materials, nailing patterns, green and dry lumber, openings in the diaphragms, and different methods of boundary construction.

A pin-connected steel-and-timber truss was used in testing the diaphragms. Loads were applied by two 30-ton hydraulic jacks connected in unison. The load was applied to the fifth points of one 60-ft flange member. The load was applied in steps to a predetermined level, then released to a zero load; the same procedure was followed for each new load level. In some cases, after the first load run was completed, five additional runs were made at the same load level to determine the load at which the deflection and set became excessive.

Horizontal deflection readings were taken along the unloaded chord and both endposts. In addition, buckling in the framing members, sheathing movement, and strain across joints and within members of the tension chord were measured.

Structural and Environmental Evaluation of Prefabricated Buildings. William B. Strandberg, Corps of Engineers, Engineering Research and Development Laboratories.

Report of Committee C-7 on Lime. J. A. Murray, Chairman.

Report of Committee C-19 on Structural Sandwich Constructions. E. W. Kuenzi, Chairman.

Report of Committee C-20 on Acoustical Materials. H. A. Leedy, Chairman.

Report of Committee D-7 on Wood. L. J. Markwardt, Chairman.

Report of Committee E-6 on Methods of Testing Building Constructions. J. A. Liska, Chairman.

Friday, June 18 9:00 a.m. Thirty-fourth Session

Held simultaneously with the Thirty-third and Thirty-fifth Sessions

Session on Plastics

Measuring Viscosity of Thermosetting Resins by Parallel Plate Plastometry. Donald I. Marshall, Bakelite Co.

Because of the fast hardening encountered, few viscosity test methods are applicable to the very viscous thermosetting resins. This paper describes a parallel plant plastometer method capable of measuring the viscosity of thermosetting Newtonian fluids over the viscosity range from 10 to 10^7 poises. The test is fast enough to permit following rapid viscosity changes during thermal hardening at elevated temperatures.

It is shown to be applicable to two-stage and resol types of phenol-formaldehyde resins and a polysiloxane resin. It was applicable in some degree to a solid epoxy resin and a spray-dried urea-formaldehyde resin, but was not applicable to a melamine molding resin where non-Newtonian behavior and excessively high viscosity were encountered.

Effect of Crystallinity, Residual Stress and Aging on Creep of Kel-F, Geon, and Canvas Laminate Respectively. W. N. Findley, University of Illinois.

The paper presents tension creep data at 77 F which show the effect of the following variables: (*a*) the degree of crystallization of monochlorotrifluoroethylene (Kel-F), (*b*) residual stresses remaining after fabrication of sheets of polyvinylchloride (Geon 404), and (*c*) aging of Grade-C canvas laminate at 77 F and 50 per cent relative humidity.

The Kel-F was tested in the amorphous, fully crystalline, and intermediate (commercial) state. The effect of residual stresses was shown by tests of samples of Geon 404 before and after an anneal at 275 F which resulted in shrinkage of the material. The canvas laminate was tested in creep before and after aging at constant temperature and humidity for about 10 yr.

Creep Time Relations for Nylon in Tension, Compression, Bending and Torsion. Joseph Marin, The Pennsylvania State University, A. C. Webber, E. I. du Pont de Nemours & Co., Inc., and G. Weissmann, Bell Telephone Laboratories.

This paper presents the results of an investigation dealing primarily with the creep deformation-time relations of nylon FM 10001 and nylon FM 3001 under various types of stress. The stresses considered include tension, compression, pure bending, and pure torsion. For each of these stresses the influence of the stress magnitude upon the creep-time relations was investigated.

To determine whether the creep deformation-time relations for torsion and bending could be predicted based on the tension and compression creep-time relations, theoretical relations for torsion and bending creep were developed. These relations were based upon empirical equations defining creep deformation-time variations in tension and compression. A comparison of these theoretical creep-time relations for torsion and bending with the actual values showed good agreement between actual and theoretical values.

Special creep tests were also made to evaluate the extent of creep recovery resulting on the removal of stress. It was found that a large part of the total creep strain was recovered on load removal. A series of tests was also conducted to determine the influence of rest periods upon the creep-stress-time relations. A small amount of creep recovery was found to occur during overnight rest periods between "cycling" tests.

Time-Temperature Relationship for Rupture Stresses in Reinforced Plastics. S. Goldfein, Engineer, Corps of Engineers, Research and Development Laboratories.

Proposed utilization of laminates fabricated from polyester resins reinforced with glass fibers in Corps of Engineers equipment which has to sustain appreciable loads over relatively long periods of time, has led to the investigation of the relationship between time, temperature, and rupture stresses in these materials. It was found that a time-temperature relationship developed for the study of rupture stresses in metals at elevated temperatures could be applied to these materials with considerable success. Application of this relation allows the use of short-time tests at elevated temperatures to determine long-time data at room temperature and allows the presentation of the complete rupture characteristics of a laminate on a single curve.

Report of Committee D-14 on Adhesives. Gerald Reinsmith, Chairman.

Report of Committee D-20 on Plastics. R. K. Witt, Chairman.

Report of Committee D-23 on Cellulose and Cellulose Derivatives. F. A. Simmonds, Chairman.

Friday, June 18 9:00 a.m. Thirty-fifth Session

Held simultaneously with the Thirty-third and Thirty-fourth Sessions

Session on Impact Testing

Poisson Effect in the Charpy Test. Carl E. Hartbower, Watertown Arsenal Lab.

It is generally recognized in evaluating the transition from ductile to brittle behavior in metals that the choice of test specimen is far less critical to correlation of test results than is the choice of criterion used in establishing the transition. It is the purpose of this paper to discuss the meaning and measurement of the Poisson effect in the V-notch and keyhole Charpy tests. It will be demonstrated that the deformation attending the fracture of a Charpy bar can be measured as either the lateral contraction occurring beneath the notch or, more easily, by the lateral expansion occurring at the compression surface of the test bar. Moreover, it will be shown that a linear relationship exists between lateral contraction and lateral expansion and the energy required to produce fracture over an appreciable range of energy absorption. Therefore, measurement of the change in lateral dimension is a duplication of effort when the energy in impact testing can be read directly from the calibrated dial of the testing machine.

Effect of Microstructure on the Elevated Temperature Strength of Alloy Steel. J. J. Heger, J. M. Hodge, and P. W. Marshall, United States Steel Corp.

The tensile properties at room temperature and at 1000, 1100, and 1200 F. and the creep rupture strengths at 1000, 1100, and 1020F, in a 2 Cr, 0.5 Mo steel were evaluated as a function of microstructure. The microstructures studied were as follows: (1) coarse pearlite, (2) fine pearlite, (3) upper bainite, (4) lower bainite, and (5) martensite.

Very significant effects of microstructure were found in short-time tests, but the differences in elevated temperature strengths among the various microstructures decreased markedly as the time and temperature of testing increased.

Properties of Hardened 1040, 4340, and Ni-Cr-Mo-V Steels Up to 1000 F. G. V. Smith and W. B. Seens, United States Steel Corp.

Short-time tensile properties at 80, 500, 700, 850 and 1000 F and creep-rupture properties at 850 and 1000 F are reported for 1040, 4340, and Ni, Cr, Mo, V (0.4 C) steels heat treated to a tensile strength of 150,000 psi at room temperature. The 1040 steel was also tested in creep rupture at 500 and 700 F.

Effect of Specimen Size on Notched Bar Impact Properties of Quenched and Tempered Steels. Harry Schwartzbart and J. P. Sheehan, Armour Research Foundation.

The authors discuss the effect of specimen size on impact properties of 8600 steel at four carbon levels, 5140 and 4140, quenched and tempered at temperatures from 400 to 1200 F. They conclude that: (1) maximum impact energy per unit fracture area (area under the notch) is relatively independent of specimen size at tempering temperatures from 400 to 700 to 800 F, is dependent on specimen size at tempering temperatures between 700 to 800 and 1200 F; (2) maximum impact energy per unit volume decreases with increasing specimen size; (3) a distinct size effect is exhibited in transition temperature, and (4) for the 8600 series of steel, transition temperature increases with carbon content.

Notch Bar Tests of High Strength Steel. Richard H. Raring and J. A. Rinebolt, Naval Research Laboratory.

Charpy V-notch specimens of AISI 4340 steel heat treated to 210,000 and 230,000 psi were tested over a temperature range of from 320 to − 320 F by the conventional impact test and by slow-bending. The energy absorption in the slow-bend test was calculated from automatically recorded load-deflection curves. The effect of temperature on the volume of plastically strained material in the broken specimens was studied.

Transitions were indicated by the impact energy absorption and by the volume of strained metal. The energy as calculated from the slow-bend data, however, failed to indicate a transition.

Friday, June 18 11:30 p.m. Thirty-sixth Session

Committee Report Session

A-3 on Cast Iron. J. S. Vanick, Chairman.

C-9 on Concrete and Concrete Aggregates. L. W. Teller, Chairman.

C-12 on Mortars for Unit Masonry. J. M. Hardesty, Chairman.

D-2 on Petroleum Products and Lubricants. O. L. Maag, Chairman.

D-8 on Bituminous Waterproofing and Roofing Materials. H. R. Snoke, Chairman.

D-15 on Engine Antifreezes. H. R. Wolf, Chairman.

D-19 on Industrial Water. Max Hecht, Chairman.

D-21 on Wax Polishes and Related Materials. W. W. Walton, Chairman.

E-12 on Appearance. M. Rea Paul, Chairman.

Joint Committee on Effect of Temperature on the Properties of Metals. F. B. Foley, Chairman.

Standards Committee Acts on Proposals from Steel, Adhesives, Metallography, and Filler Metals Committees

As SHOWN in the accompanying box, the Administrative Committee on Standards took action on March 3 and March 17 on four recommendations from Committees A-1 on Steel, D-14 on Adhesives, E-4 on Metallography, and the Joint AWS-ASTM Committee on Filler Metal.

Steel

Dissatisfaction was expressed by Government personnel several years ago over specifying structural steel furnished to ASTM Tentative Specifications for Steel for Bridges and Buildings (A 7) for welding purposes. Agreement was reached in the new Tentative Specifications for Structural Steel for Welding (A 373) and it was decided to divorce the new specifications from A 7 to avoid stocking confusion. This new specification covers "carbon steel plates, shapes, and bars of structural quality not over 4 in. in thickness for use in the construction of welded bridges and buildings and for general welded structural purposes."

Adhesives

Committee D-14 taking cognizance of the fact that some adhesives are intended to be cured by electronic heating and some are intended to provide electrical insulation or to be used in electrical apparatus, has assembled in Tentative Methods of Test for Adhesives Relative to Their Use as Electrical Insulation (D 1304) the means for determining the adaptability of adhesives of varying types and states for such usage.

The committee also recommended revision of the Standard Definitions of Terms Relating to Adhesives (D 907) to include definitions of the terms diluent, plywood, glued laminated wood, and built-up laminated wood as follows:

Diluent.—An ingredient, usually added to an adhesive to reduce the concentration of bonding materials.

Plywood.—A cross-bonded assembly made of layers of veneer or veneer in combination with a lumber core or plies joined with an adhesive. Two types of plywood are recognized, namely (1) veneer plywood and (2) lumber core plywood. NOTE: Generally the grain of one or more plies is approximately at right angles to the other plies and almost always an odd number of plies are used.

Glued Laminated Wood.—An assembly made by bonding layers of veneer or lumber with an adhesive so that the grain of all laminations is essentially parallel.

Built-up Laminated Wood.—An assembly made by joining layers of lumber with mechanical fastenings so that the grain of all laminations is essentially parallel.

Metallography

Committee E-4 proposed revision of Tentative Methods for Preparing Quantitative Pole Figures of Metals (E 81) to bring it in line with present advanced practices. The method, employing the Geiger counter spectrometer, to prepare quantitative pole figures is applicable to cold-worked metals or with certain limitations, to recrystallized metals. The method incorporates the calculation of an "orientation index" as a measure of the degree of preferred orientation, or deviation from randomness.

Filler Metal

The Joint AWS-ASTM Committee on Filler Metal has prepared Specifications for Aluminum and Aluminum-Alloy Welding Rods and Bare Electrodes (B 285) which are urgently needed by industry because of the current widespread use of inert-gas metal-arc welding.

Actions Taken by Administrative Committee on Standards in March

New Tentatives

Method of:

Test for Adhesives Relative to Their Use as Electrical Insulation (D 1304 – 54 T) (Approved March 17)

Specifications for:

Aluminum and Aluminum-Alloy Welding Rods and Bare Electrodes (B 285 – 54 T) (Approved March 17)

Structural Steel for Welding (A-373) (Approved March 31)

Electrical Insulating Paper, Interlayer Type (D 1305 – 54 T). (Corrected designation—see April issue)

Tentative Revision of Standards

Definitions of:

Terms Relating to Adhesives (D907 – 54 T) (Approved March 3)

Revision of Tentative

Method for:

Preparing Quantitative Pole Figures of Metals (E 81 – 54 T) (Approved March 3)

Book of Standards Purchased for Largest U. S. Information Centers

ONE hundred copies of the complete seven-volume edition of the 1952 Book of ASTM Standards was purchased recently by the U. S. Department of State for distribution through the United States Information Agency, to the largest American Information Centers in all parts of the world. As would be expected, the big Book went mainly to Centers in highly industrialized areas such as Western Europe, Japan, and parts of Latin America but large Centers in other areas also received copies.

The United States Information Agency was established in August, 1953, to cover overseas information functions and to provide basic knowledge about the USA, needed scientific and technical data, and evidence of the American spiritual and cultural tradition.

The distribution made by the State Department supplements the regular flow of Books of Standards to members who are scattered throughout the world and to nonmembers who order them.

Continuing demands for the Society's publications, particularly those containing standards, either the Book of ASTM Standards or special compilations or separates, are encouraging. If the maximum benefits are to come from the intensive efforts of our Society and committee members, the products of ASTM, especially the standards, must be used. Obviously a wider distribution of the standards is effective in stimulating their use.

Through its Committee on Developmental Activities, the Board of Directors is carrying out studies and developing a program for increasing a knowledge of the Society and the use of the end results from its extensive research and standardization programs. Wider dissemination of the standards is one of the aims in this work.

NEW ASTM PUBLICATIONS

New Wood Compilation

FOR the first time, the various ASTM standard and tentative specifications, test methods, and definitions of terms pertaining to wood, wood-base materials, and wood preservatives have been brought together in convenient form in a separate publication. This compilation is sponsored by Committee D-7 on Wood.

These standards and tentatives represent many years of development and refinement of means of evaluating mechanical and physical properties of wood, veneer, plywood and fiber building boards; chemical analysis, structural grading and specifications for wood and timber; fire tests; and specifications and chemical analysis of wood preservatives. Here are the contents of the new compilation:

Wood, Veneer, Plywood, and Fiber Building Boards

Methods of Test for:
- Small Clear Specimens of Timber
- Veneer, Plywood, and Other Glued Veneer Constructions
- Building Boards (Evaluating Properties)
- Timbers in Structural Sizes (Static Tests)
- Wood Poles (Static Tests)

Building Constructions and Structural Units

Methods of Test for:
- Panels for Building Construction (Conducting Strength Tests)
- Truss Assemblies
- Integrity of Glue Joints in Laminated Wood Products for Exterior Service

Methods of Chemical Analysis

Methods of Test for:
- Ash in Wood
- Alpha-Cellulose in Cellulosic Materials
- Holocellulose in Wood
- Extractive-Free Wood (Preparation of)
- Lignin in Wood
- Methoxyl Groups in Wood and Related Materials
- Alcohol-Benzene Solubility of Wood
- Ether Solubility of Wood
- One Per Cent Caustic Soda Solubility of Wood
- Water Solubility of Wood

Definitions of Terms

Definitions of Terms Relating to:
- Timber
- Veneer and Plywood
- Domestic Hardwoods and Softwoods (Nomenclature)

Methods of Structural Grading and Specifications for Wood and Timber

Methods for:
- Establishing Structural Grades of Lumber

Specifications for:
- Round Timber Piles
- Wooden Paving Blocks for Exposed Pavements
- Creosoted End-Grain Wood Block Flooring for Interior Use
- Wood to Be Used as Panels in Weathering Tests of Paints and Varnishes

Fire Tests of Building Materials and Constructions

Methods of Test for:
- Combustible Properties of Treated Wood by Crib Test
- Combustible Properties of Treated Wood by the Fire-Tube Apparatus
- Fire Tests of Building Construction and Materials
- Fire Tests of Door Assemblies
- Fire Hazard Classification of Building Materials

Wood Preservatives

Specifications for:
- Creosote
- Creosote-Coal Tar Solution
- Zinc Chloride
- Chromated Zinc Chloride
- Copperized Chromated Zinc Chloride
- Pentachlorophenol
- Tanalith

Methods of Test for:
- Sampling and Testing Creosote
- Coke Residue (Creosote)
- Distillation (Creosote)
- Distillation of Gas Oil and Similar Distillate Fuel Oils
- Flash Point by Means of the Pensky-Martens Closed Tester
- Float Test for Bituminous Materials
- Benzene-Insoluble Matter in Creosote
- Gravity of Petroleum and Its Products by Hydrometer
- Specific Gravity of Creosote
- Specific Gravity 38/15/5 C of Creosote Fractions
- Tar Acids in Creosote and Creosote-Coal Tar Solutions
- Viscosity by Means of the Saybolt Viscosimeter
- Volume and Specific Gravity Correction Tables for Creosote and Coal Tar
- Water in Creosote
- Water and Sediment by Means of Centrifuge

Methods for Chemical Analysis of:
- Zinc Chloride
- Chromated Zinc Chloride
- Copperized Chromated Zinc Chloride
- Pentachlorophenol
- Tanalith

Definitions of Terms Relating to:
- Timber Preservatives

It is believed that this publication will be useful to producers and consumers of wood, wood-base materials, and wood preservatives, as well as to specification writers, testing and inspection personnel, and to research and engineering institutions.

The standards on wood preservatives are closely coordinated with the standards of the American Wood Preservers Assn.

356 pages, heavy paper cover, 6 by 9 in. Price: $3.75; to ASTM members, $2.80.

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Latest Piping Compilation

THE compilation on steel piping materials contains the widely used specifications, developed by Committee A-1 on Steel, covering pipe, tubing, castings, forgings, bolting, and related materials used in piping installations. Those concerned with pressure piping, power generating, or the petroleum field, and others should find the book a decided convenience. The grain-size chart E 19 is a part of this book also.

The 1954 edition contains a total of 55 standards. Of these, 22 have been revised and one new specification has been included, since issuance of the last compilation. The new specification is a tentative for Ferritic Alloy Steel and Alloy Steel Forged and Bored Pipe for High Temperature Service (A 369 – 53 T).

In this 384-page edition there are Emergency Alternate provisions in only 10 of the specifications—the last issue had 16. (All of the Emergency Alternates covering decreases in minimum molybdenum content have been withdrawn.)

Price $3.75; to ASTM members $2.80.

• • •

New Edition of ASTM Standards on Cement

THE 12th Edition of the compilation of ASTM Standards on Cement is now being printed. This widely used publication, in keeping abreast of the developments in cement testing, contains one new tentative method, Mechanical Mixing of Hydraulic Cement Mortars of Plastic Consistency (C 305 – 53 T). Several revisions of standards and tentatives are found, including the provision for more stringent soundness requirements for masonry cement in C 91 and refinements in the air permeability method for fineness of portland cement (C 204). A definition of the term "pozzolan" now is included in the list of definitions found in C 219.

The compilation also contains the Manual of Cement Testing, along with an extensive list of selected references on portland cement and information on balances and weights.

Price $2.75; to ASTM Members, $2.

Cement Reference Laboratory Celebrates 25th Anniversary

In the closing days of 1928, three prominent members of ASTM Committee C-1 on Cement, F. W. Kelley, Cloyd M. Chapman, and Richard L. Humphrey, paid calls on the Director of the National Bureau of Standards, the Secretary of Commerce, and the Director of the Budget Bureau. So effective were they in carrying out their assignment that one of the last bills to pass the 70th Congress contained an appropriation of $12,500 to the National Bureau of Standards for the establishment of a Cement Reference Laboratory.

This appropriation, already matched by funds made available to ASTM by the Portland Cement Assn., made possible the actual beginning of operation in mid-1929 of the Laboratory which this year celebrates its 25th anniversary as a useful, active example of cooperative enterprise among Government, industry, and professional groups.

Having secured the funds necessary to establish the fellowship, the Society arranged a meeting in March, 1929, in Washington where Dr. Burgess, then Director of the National Bureau of Standards, Dr. G. W. Thompson, President of ASTM, and P. H. Bates, chairman of Committee C-1, met with the Special Committee on Reference Laboratory to formulate a detailed plan for carrying on the work of the Laboratory. Among their stated goals were:

TO establish a laboratory with apparatus and personnel capable of making tests of portland cement in strict conformance with the specifications.

TO instruct on established methods of making tests, maintaining testing equipment, and to calibrate testing equipment when submitted.

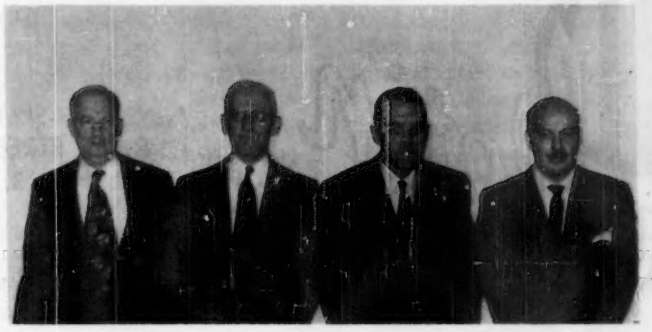
TO report, when requested to, on the adequacy and accuracy of apparatus to make cement tests to conform with standard specifications and to issue suitable certificates covering apparatus to those entitled to them.

The latest report of the Laboratory's activities reveals how these duties are being carried out.

In 1953, the Laboratory completed a three-year tour of inspection which covered 261 state highway, university, municipal, and commercial laboratories. Of these, 156 are represented on Committee C-1. In this work the Laboratory's experts checked on balances, Vicat instruments, Gilmore needles, air content apparatus, glass graduates, flow tables, compression, tension, and flexure testing apparatus.

The Laboratory has also recently conducted a comparative test series on standard samples of cement in which 206 laboratories participated in the tests of samples of cement distributed by the Laboratory.

Faithful performance of these duties over the past quarter century under the direction of John R. Dwyer, Research Associate, National Bureau of Standards, has amply demonstrated the value of this organization to the industry.



Members of the Cement Committee's Subcommittee on Cement Reference Laboratory are left to right: John R. Dwyer; F. H. Jackson, Vice Chairman; D. S. MacBride, Chairman; and A. Allan Bates.

Extensive Program Prepared for 50th Anniversary of IEC

Seven hundred electrical technical experts from 29 countries and the U. S. will attend the fiftieth anniversary meeting of the International Electrotechnical Commission (IEC) to be held on the campus of the University of Pennsylvania, Philadelphia, September 1 to 16.

Dr. Harold S. Osborne, formerly chief engineer, American Telephone and Telegraph Co., is IEC president and Richard C. Sogge, General Electric Co., is president of the U. S. National Committee of IEC. P. H. Chase, Philadelphia Electric Co., is chairman of the General Committee in charge of arrangements.

The delegates will hold 226 morning and afternoon sessions in which they will work on international standards in the fields of electric light, power, and communications. About 300 of those attending will come from foreign countries.

The work of the IEC is carried on by 37 technical committees, 26 of which will hold sessions in Philadelphia. The work covers the entire field of the electrical art and includes such specific committee subjects as dimensions of motors, standard voltages, current ratings and frequencies, overhead lines, safety, insulating materials, and electronic tubes.

The United States heads five of the committees: steam and hydraulic turbines, internal combustion engines, letter symbols and signs, and lightning arrestors.

The Philadelphia meetings will include an all-day Jubilee celebration on September 9 commemorating 50 years of IEC. Speakers will be Lord Waverly, chairman of the Port of London Authority and past-president of the British Standards Institution; Dr. Hakan Sterky, head of the Swedish communication system; M. Pierre P. Ailleret, director of Electricité de France; and Dr. Lee A. DuBridge, president, California Institute of Technology. A banquet in the Bellevue-Stratford Hotel will be held that evening.

The IEC was founded in St. Louis in 1904 with Lord Kelvin (Sir William Thomson) of England as first president. The first and only meeting held in this country took place in New York in 1926.

The IEC has published 30 International Recommendations. These are recognized by all members as expressing as nearly as possible an international consensus on the subjects dealt with. Each country undertakes to make every effort to harmonize its national electrical standards with the recommendations insofar as national conditions permit.

ASTM Bulletin

MAY 1954

NO. 198

NINETEEN-SIXTEEN
RACE STREET
PHILADELPHIA 3, PENNA.

The Officers Go West

ONE returns from a long business trip sometimes with mixed emotions, but the national officers who, in February and March, spoke at numerous ASTM District meetings, beginning in Buffalo and extending to the Northwest, were pleased and stimulated by the wonderful reception given them by members and the other cooperating District and Section officers in each of the industrial centers visited. (News of these meetings appears on page 37.)

Any 8500-mile trip requires much planning, particularly where meetings are involved, and a not inconsiderable expenditure of physical effort. And a mental hazard involved is the assurance, fully realized in this instance, of tasks piling up at the home office.

Nevertheless, these annual visits which the national officers make to the Southwest and West Coast embody much good for ASTM and the individuals. They provide an opportunity for local members to become better acquainted. Each president in his district technical talk brings in one or more phases of ASTM research and standardization activities that, together with short messages from Headquarters officials, widens the knowledge of the Society and what it does.

The industrial development of the Southwest and West has increased our membership and committee contacts there, but we should and will have more members and it is important that the industries in these areas be adequately represented on our committees—not only from their viewpoint but from the broader one of making contributions and advancing standardization and research. Steps in this direction are encouraging.

Not the least among the results of these visits are the personal friendships developed, a wider conception of various problems confronting our members, and a renewal of the inspiration which is always derived from the wonderful cooperation given the officers of the Society by members and committee members everywhere.

The work of the Society is national and international in scope. ASTM is not the Staff or the directorate—it is our members and committee members throughout this and other lands. On this trip President Beard and Executive Secretary Painter had many examples of the widespread recognition accorded ASTM and the high esteem in which it is held. This but reflects the interest and work in this great Society of the men who are ASTM.

Proceedings—A Milestone

WITH the mailing of the annual *Proceedings*, another milestone has been reached. This is said despite the fact that the *Proceedings* no longer loom quite as large relatively as they did formerly. Years ago, the appearance of the *Proceedings* represented the culmination of the Society year and constituted the tangible product of the Society's efforts in the advancement of knowledge of engineering materials, whereas today there are many special publications comprising symposiums or compilation of data.

However, despite this change in relative position, the *Proceedings* are still the main repository of factual information and a record of technical accomplishments during the year. They represent the "Proceedings" for the year—not solely of the Annual Meeting as was formerly the case—and a change in designation was made several years ago to indicate this.

One fact should always be emphasized: in addition to the reports and technical papers, the *Proceedings* contain much discussion that has been submitted. Frequently this discussion contributes greatly to the subject. Also, the *Proceedings* contain a complete record of all technical publications issued during the calendar year.

Schedule of ASTM Meetings

This gives the latest information available at ASTM Headquarters. Direct mail notices of all district and committee meetings customarily distributed by the officers of the respective groups should be the final source of information on dates and location of meetings. This schedule does not attempt to list all meetings of smaller sections and subgroups.

DATE	GROUP	PLACE
May 11	Committee E-11 on Quality Control of Materials	Philadelphia, Pa. (Benjamin Franklin Hotel)
May 13–14	Committee C-20 on Acoustical Materials	Madison, Wis. (Edgewater Hotel)
May 24–26	Committee E-14 on Mass Spectroscopy	New Orleans, La. (Hotel Jung)
May 26	Committee D-21 on Wax Polishes and Related Material	Cincinnati, Ohio (Netherlands-Plaza Hotel)
June 13–18	**ASTM Annual Meeting (Eleventh Exhibit of Testing and Scientific Apparatus and Laboratory Supplies and Ninth Technical Photographic Exhibit)**	**Chicago, Ill. (Sherman and Morrison Hotels)**
Sept. 16–17	Committee D-23 on Cellulose and Cellulose Derivatives	New York, N. Y.
Sept. 20–22	Committee D-20 on Plastics	Cleveland, Ohio (Carter Hotel)
Sept. 22–24	Committee D-9 on Electrical Insulating Materials	Cleveland, Ohio (Carter Hotel)
Oct. 19–20	Committee C-19 on Structural Sandwich Constructions	Lafayette, Ind. (Purdue University)

Nominations for Society Offices

THE Nominating Committee met in Chicago on March 19 to select nominees for the ASTM offices of President, Vice-President, and Board of Directors.

In accordance with the By-laws of the Society, the Nominating Committee, whose personnel was listed in the October 1952 BULLETIN, has announced the following nominations:

For President (term 1 year):

N. L. Mochel, Manager, Metallurgical Engineering, Westinghouse Electric Corp., Lester Branch P. O., Philadelphia 13, Pa.

For Vice-President (term 2 years):

R. A. Schatzel, Vice-President and Director of Engineering, Rome Cable Corp., 421 Ridge St., Rome, N. Y.

For Directors (term 3 years):

E. J. Albert, President and Treasurer, Thwing-Albert Instrument Co., Penn St. and Pulaski Ave., Philadelphia 44, Pa.

John M. Campbell, Administrative Director, Research Laboratories Div., General Motors Corp., Box 188, North End Station, Detroit 2, Mich.

Paul V. Garin, Engineer of Tests, Southern Pacific Co., 65 Market St., San Francisco 5, Calif.

John H. Jenkins, Chief, Canada Forest Products Laboratory, Pretoria and Metcalfe Sts., Ottawa, Ont., Canada.

D. E. Parsons, Chief, Building Technology Div., National Bureau of Standards, Washington 25, D. C.

Mr. Mochel has an extensive record of service in the Society, for many years serving as chairman of the Joint Committee on Effect of Temperature on the Properties of Metals, and serving longer than any other as chairman of Committee A-1 on Steel. He has presented many technical papers.

Mr. Schatzel is an authority in the field of rubber and rubber-like materials, particularly insulated wire and cable. He has been concerned especially with Committee D-11 but also serves on other ASTM technical committees. He has been very active in civic affairs in his home city.

Mr. Albert, currently President of the Scientific Apparatus Makers of America, has been active in Philadelphia District work, and serves on various ASTM committees, including Committees D-9 on Electrical Insulating Materials and D-6 on Paper and Paper Products.

Mr. Campbell has been particularly concerned with petroleum products and lubricants and serves on Committee D-2 on Petroleum Products and Lubricants.

Mr. Garin, who has been very active in ASTM West Coast affairs, is currently chairman of the Northern California District. He serves on the ASTM Steel Committee and other groups.

Mr. Jenkins' specialty is timber and timber products and he is known internationally for his work in this field. His laboratory has been particularly concerned with the work of Committee D-7.

Mr. Parsons, an authority on building materials, has served ASTM in many capacities. Currently he is on the Administrative Committee on Standards and for many years was chairman of the Committee on Manufactured Masonry Units.

Acceptance of the nomination has been indicated in writing by each of the nominees. The By-laws provide that "further nominations, signed by at least 25 members, may be submitted to the Executive Secretary in writing by May 25, and a nomination so made, if accepted by the member nominated, shall be placed on the official ballot" which "shall be issued to members between May 25 and June 1."

N. L. Mochel Honored at Steel Meeting

NORMAN L. MOCHEL, for 15 years chairman of Committee A-1 previous to his resignation in 1953 to assume the position as Senior Vice-President of the Society, was presented with an engrossed scroll by the committee at its Pittsburgh meeting, Jan. 27, 1954. The scroll (see copy at right) signed by upwards of 100 members of the committee, expressed the great appreciation of producers and consumers alike for his 15 years of continuous service. This term of office exceeded that of any of the previous chairmen, beginning with W. R. Webster in 1899.

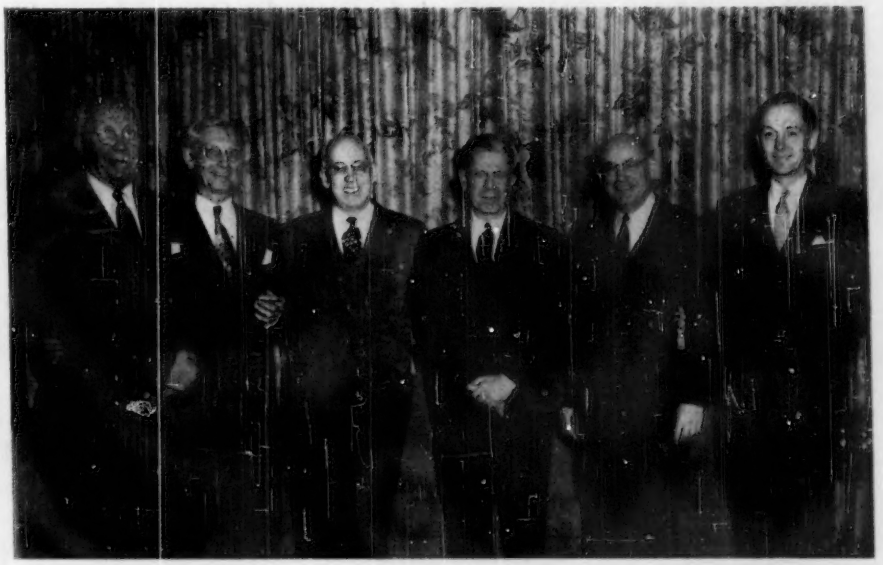
At a dinner on January 26, Mr. Mochel received from the A-1 Advisory Committee a silver platter engraved with a suitable inscription and the signatures of members of the present Advisory Committee, as well as many past members.

COMMITTEE A-1 ON STEEL
AMERICAN SOCIETY FOR TESTING MATERIALS

Extends to

Norman L. Mochel

Deep appreciation and respect for the outstanding services given through 15 years as chairman of the main committee, as chairman of various subcommittees, and as a leader in many other phases of the work. The notable record of accomplishment is itself a tribute to your guidance and leadership. This Testimonial also evidences a strong feeling of admiration and respect accorded you by those from both the consuming and producing interests. We are grateful for your understanding; we appreciate the time and energy you have devoted so unselfishly to this outstanding work; and we value highly our personal contacts and friendships with you.



In the Committee A-1 group honoring Norman L. Mochel are left to right: H. B. Oatley, Chairman; T. G. Stitt; W. F. Collins, Vice Chairman; Mr. Mochel; C. E. Loos, Vice Chairman; and J. S. Worth, Secretary.

Society Officer J. R. Townsend Heads New Materials Advisory Board

JOHN R. TOWNSEND, currently ASTM Director and a past-president of the Society, has recently been appointed chairman of the Materials Advisory Board of the National Academy of Sciences.

This new Board succeeds the Academy's Minerals and Metals Advisory Board which has been supplying information to the Department of Defense on conservation of materials and areas in which materials research should be fostered. Scope of the new Board was enlarged at the request of D. A. Quarles, Assistant Secretary of Defense, Research and Development, and as a result will include experts in nonmetallic materials such as plastics, wood products, ceramics, etc.

The proposed membership of the new Board includes, in addition to Mr. Townsend, who is Director, Materials and Standards Engineering, Sandia Corp., the following:

Vice-Chairman, Francis C. Frary, Technical Adviser, Aluminum Company of America

E. C. Bain, Vice-President, U. S. Steel Co.

E. K. Bolton, Chemical Director (Retired), E. I. du Pont de Nemours & Co.

S. M. Cadwell, Director, Research and Development, U. S. Rubber Co.

John Chipman, Head, Department of Metallurgy, Massachusetts Institute of Technology

James H. Critchett, Vice-President (retired), Union Carbide & Carbon Research Labs.

Alvin J. Herzig, President, Climax Molybdenum Co. of Michigan

Matthew A. Hunter, Dean of Faculty Emeritus, Rensselaer Polytechnic Institute

Zay Jeffries, Vice-President (retired), General Electric Co.

Walter E. Jominy, Chief Research Metallurgist, Chrysler Corp.

C. K. Leith, Emeritus Professor of Economic Geology, University of Wisconsin

D. H. McLaughlin, President, Homestake Mining Co.

L. J. Markwardt, Forest Products Laboratory

C. S. Marvel, Professor of Organic Chemistry, University of Illinois

Robert F. Mehl, Dean of Graduate School, Carnegie Institute of Technology

H. J. Osterhof, Director of Research, Goodyear Tire & Rubber Co.

Albert J. Phillips, Director of Research, American Smelting & Refining Co.

Oliver C. Ralston, Chief Metallurgist, U. S. Bureau of Mines

Cyril S. Smith, Director, Institute for Study of Metals, University of Chicago

E. C. Smith, Chief Metallurgist, Republic Steel Corp.

John G. Thompson, Chief Metallurgist, National Bureau of Standards

Hans Thurnauer, Director of Research, American Lava Corp.

Walter C. Voss, Professor of Building Construction, Massachusetts Institute of Technology

Clyde Williams, Director, Battelle Memorial Inst.

Election of District Councilors Under Way

IN May of each year ASTM members in the various Districts of the Society receive ballots from Headquarters for the election of District officers or councilors, or both.

The offices of chairman, vice-chairman, and secretary are filled by election in the even numbered years for terms of two years. The two-year terms of councilors are staggered so that about half expire every year. This means that elections for officers will be held in 1954 as well as for those councilors whose terms are ending.

Under the Charter for Districts, provision is made for a nominating committee of five members appointed by the District chairman with approval of the council. This committee is usually composed of one councilor, three non-councilors from the District, and the immediate past-chairman who heads the committee. These committees have recently been holding their meetings to prepare the recommendations which appear on the letter ballot. Provision is made on the ballot for the writing in of additional names for officers and council membership.

Committee on International Plastics Standards to Meet in England

AT THE invitation of the British Standards Institution, Technical Committee 61 (Plastics) of the International Standards Organization will meet in London during the week of October 4. The United States delegation to TC61 will be headed by ASTM's Robert Burns, Bell Telephone Laboratories.

Corrections in Methods D 928

A "PRINTER'S pie" has resulted in a major error in Section 3 of the Standard Specifications for Sodium Bicarbonate (D 928–52). The numbers in the second column of the table in Section 3 should, when properly rearranged, read as follows, from top to bottom: 0.4, 99.6, 0.1.

We hope your name appears correctly in our membership records . . . .

TO ASTM MEMBERS . . .

If we do not have your latest business connection and address (see 1953 ASTM Year Book) please fill out and return the blank below. HELP US KEEP YOUR MEMBERSHIP RECORDS UP TO DATE.

ASTM MEMBERSHIP FILE

Please correct membership to read:

Name.....
(*Please print*)

Business Title or Position.....

Company.....

Company Address.....

.....
City **Zone No.** **State**

Residence
(*If desired*).....

District Activities

President and Executive Secretary Make 8500-Mile Swing to Southwest and West Coast Districts

"Something Has Been Added," President Beard's Talk, Stimulates Discussion

ASTM President L. C. Beard, Jr., Socony-Vacuum Laboratories, New York, and Executive Secretary R. J. Painter returned on March 10 from an 8500-mile railway trip during which the president spoke at eight technical meetings and attended numerous conferences. Both were very gratified at the very cordial reception accorded them, and, as indicated in the notes below, many successful district meetings were held, many of them jointly with local sections of other national societies.

The technical feature of each of the meetings was the district talk presented by Dr. Beard on the subject, "Something Has Been Added." Because of the current interest in additives, the talk was timely and at each meeting prompted considerable discussion.

Since this paper is published in another portion of this BULLETIN, only a few notes concerning it appear in this article. It is expected that reprints will be printed and members can obtain a copy or two on request without charge.

A similar pattern was followed at each of the district meetings. Executive Secretary Painter spoke for about ten to fifteen minutes varying the general outline shown on page 40 and tying illustrations in with the activities of the various cooperating societies and the local industries. Then President Beard gave his illustrated talk followed by a discussion period. These periods ranged from ten minutes to over one-half hour in length.

The technical meetings in Dallas and Tacoma were the first held by ASTM in these particular industrial centers. Including the Indianapolis meeting in the fall and the forthcoming meeting April 22 in Storrs, Conn., Dr. Beard will have four "firsts" to his credit. The informal policy of arranging ASTM-sponsored technical meetings in industrial centers where they have not previously been held has met with much favor and it is expected future presidents may from time to time add to the list. It is hoped, for example, that next year the president may visit Tulsa. Certain other centers are also being considered although nothing definite can be announced pending local decisions.

The two national officers devoted an evening in Los Angeles to a joint meeting of the Southern California District Council and the officers of the General Committee on Arrangements for the 1956 National Meeting to be held in Los Angeles September 16 to 22. It was one of the purposes of the trip to complete the organization of the 1956 Committee and, considering the enthusiasm with which problems were discussed and resolved, an outstanding meeting certainly should be anticipated. (NOTE.—See the July BULLETIN for details of the 1956 Committee on Arrangements.)

Since the technical paper and the brief notes on which the Executive Secretary based his talk are given elsewhere in this BULLETIN, the purpose of the following notes is to indicate the societies which participated in the meetings and also to give some credit where it is due. Obviously, the cooperation of several people is necessary in planning and arranging a district meeting; and the very cordial relations evident in the contacts with other cooperating local sections bespeak the friendly community of interest in ASTM work.

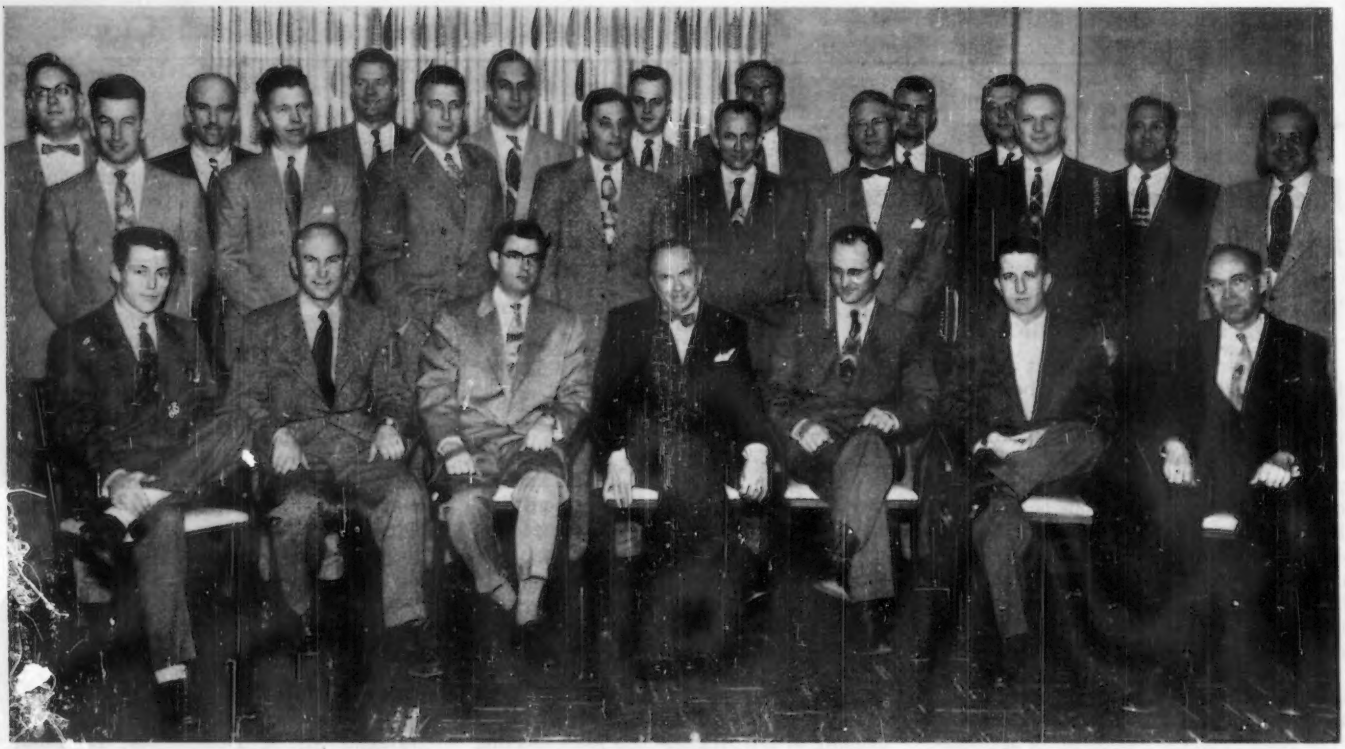
Western New York-Ontario District, Buffalo, N. Y., February 10

This dinner meeting was arranged by the District Chairman and Secretary, Messrs. J. G. Gentile and F. A. Webber. Mr. Gentile is in charge of the Pittsburgh Testing Laboratories in Buffalo and Mr. Webber is with the Buffalo Plant of Wickwire Spencer Steel Div., Colorado Fuel and Iron Corp. Although not a joint meeting, there were about 65 present, including local members of the American Society of Lubricating Engineers. Actually, this was larger than expected and although the room was crowded, it did make for a jovial, friendly meeting. The discussion was particularly interesting, with the engineers and designers as well as the lubricating petroleum specialists coming in for some good-natured criticism. National ASTM Director W. H. Lutz, Technical Director of Pratt & Lambert, Inc., joined Messrs. Beard and Painter in this meeting. It was good to see a number of those who had helped with the very successful 1946 meeting held at Buffalo, including the then arrangements chairman, T. L. Mayer, Buffalo Public Library.

St. Louis District, St. Louis, Mo., February 12

Despite a meeting on Lincoln's Birthday and a Friday at that, there was a good attendance of some 70 persons. District Chairman S. Blake Roberts, District Manager, Robert W. Hunt Co., with Secretary W. C. Magruder, Chief Chemist and Metallurgist, Carter Carburetor Corp., in close cooperation with H. C. Nason, National ASTM Director and Research Director, Organic Chemicals Div., Monsanto Chemical Co., were responsible for setting up the meeting. Again this

At the head table, St. Louis District meeting, were left to right: O. C. Johnson, Socony-Vacuum Oil Co., Inc.; W. C. Magruder, Secretary; J. M. Wendling, Vice Chairman; S. B. Roberts, Chairman; President Beard; Executive Secretary, R. J. Painter; and H. K. Nason, ASTM Director.



At Richland, Washington, left to right: (Back row) R. K. Hunter, AIChE, Arrangements Chairman; E. B. LaVelle, ASM; G. J. Alkire, ASTM; A. C. Callen, ASM; W. E. Ray, ASM; W. M. Harty, AIChE, Chairman; P. J. O'Neil, ASME, Vice-Chairman; J. J. Cadwell, ASME; T. K. Bierlein, ACS, Secretary. (Middle row) H. A. Johnson, ASM; L. D. Turner, ASM; B. R. Elder, ASM, Chairman; H. Radow, ASME; M. B. Leboeuf, ACS, Treasurer; R. J. Painter, ASTM, Executive Secretary; J. R. Carrol, ASME; H. R. Schmidt, ACS, Chairman. (Front row) R. G. Wheeler, ASM, Treasurer; R. A. Quadt, ASM; R. S. Dalrymple, ASM, Vice-Chairman; L. C. Beard, Jr., ASTM, President; J. H. Rector, ASM; M. W. Carbon, ASME, Chairman; and S. S. Jones, AIChE, Vice-Chairman.

was not a joint meeting, but several other societies received notices and were present, including the lubrication engineers, corrosion engineers, and the Society of Automotive Engineers. St. Louis has never been the scene of a national ASTM meeting and with the center of the population and members and committee members gradually going West and with many large companies and industries in the area much concerned with our work, there was some comment on the desirability of a national meeting there sometime in the future, or perhaps a Committee Week.

Southwest District, Dallas, Tex., February 15

This meeting was a joint one and scheduled as the regular monthly meeting of the North Texas Section of the National Association of Corrosion Engineers. Edwin Joyce, American Petroleum Inst., and Vice-Chairman of the ASTM Southwest District, initiated the early contacts and followed through various arrangements with the NACE officers including J. Gordon Meek, Metal Goods Corp., and Chairman, North Texas Section. R. B. Bender, Plastic Engineering and Sales Corp., handled the arrangements and Mr. Meek presided at the meeting. The facilities at the airport building were excellent for technical meetings of this kind. The airport is about midway between Dallas and Fort Worth, with a large, beautiful, new building. There was good-natured banter, following the discussion period, of the respective advantages, etc., not only of the Fort Worth and Dallas airports, but other related points. At this meeting Dr. Beard included in his talk an enlarged section dealing with the use of additives and inhibitors to do with corrosion prevention.

Southwest District, Houston, Tex., February 17

The technical meeting in the beautiful Cullen Auditorium at the University of Houston was preceded by a dinner meeting of ASTM local officers and members. Each one at the dinner was asked to indicate his field of activity for a tie-in with ASTM, demonstrating the wide diversity of professional interests and fields covered in the Society. Of course, petroleum and petrochemical field predominated in this fabulous industrial section. The district officers are anxious to stimulate wider interest in the work of the Society, and certain steps are to be taken to develop data on committee contacts, industries represented in membership, etc. The information will then be studied by the councilors.

Arrangements for the Houston meeting were carried out by the Southwest District Chairman, M. E. Holmberg, Metallurgical Consultant, with the close cooperation of J. B. Baird, District Manager, Southwestern Laboratories.

Although the attendance was not as heavy as the local officers hoped for, there were about 100 in the audience and again the discussion period was stimulating. A good many of the ASTM members in the area were in Philadelphia attending the meetings of Committee D-2 on Petroleum Products and Lubricants, but it was not possible to change the scheduled dates.

At the meeting were a number of those who aided in organizing the relatively new Southwest District, including Charles E. Lewis, Metallurgical Engineer, Cook Heat Treating Co.; James Earthman, Engineer, Wyatt Metal and Boiler Works; and A. B. Campbell, Executive Secretary, National Association of Corrosion Engineers.

Southern California District, Alhambra, Calif., February 23

The officers had a very busy four and one-half days in Los Angeles. National, ASTM Director E. Ord Slater had arranged several contacts, including meetings with the dean and members of the faculty at the University of Southern California and also at the Engineering School of UCLA where the Deans, Messrs. Vivian and Boelter respectively, serve on the ASTM District Council. At USC it was good to see Dr. Harry L. Fisher, ASTM Marburg Lecturer in 1941, who is supervising installation of the rubber research and fabricating laboratory under the sponsorship of the California rubber group.

The technical meeting, a joint one with the Southern California Section of AIChE, was outstanding, with over 250 at the

The Northern-California District Council on the occasion of luncheon meeting held in honor of L. C. Beard and R. J. Painter. Standing, l. to r.: G. H. Raitt, W. B. Kennedy (representing Mr. C. H. Fitzwilson), W. N. Lindblad, H. de Bussieres, H. D Imrie, R. C. Vollmar, J. H. Dunn, R. J. Painter, Dozier Finley, R. C. Clark (representing R. W. Harrington), and T. P. Dresser, Jr. Seated, l. to r.: G. J. Grieve, L. A. O'Leary, F. M. Harris, L. C. Beard, Jr., P. V. Garin, H. P. Hoopes, and P. E. McCoy.

technical session and about the same number at the preceding dinner. The dinner and meeting were at the plant of C. F. Braun and Co. at Alhambra, where the ASTM District Chairman, Dr. Elmer O. Bergman, is Consulting Engineer; the AIChE Chairman, Arnold M. Ames, is also on the technical staff. The meeting hall was just comfortably filled so that some dozen ladies who had come to greet President Beard and Mmes. Beard and Painter had their own session in the company's reception parlors. General arrangements for the meeting had been carried out by Dr. Bergman with the close help of Myron B. Niesley, who heads the California Testing Laboratories. Other district councilors and officers participated, including Vice-Chairman J. B. Morey, Mechanical Engineer, The International Nickel Co., Inc. The accompanying photographs show the ASTM and AIChE officers.

Messrs. Beard and Painter are particularly appreciative of the considerable amount of time which the Southern California officers devoted to ASTM business, in particular, National Director E. O. Slater and District Chairman E. O. Bergman. There was excellent attendance as usual at the council meeting and 1956 Arrangements Committee gathering on Monday, February 22, and most of those present as well as the few missing councilors were at the technical meeting on Tuesday. Members in other sections of the country can count on this group in collaborating with their Northern California associates in arranging an extremely interesting national meeting September 16 to 22, 1956, at the Hotel Statler.

Northern California District, Berkeley, Calif., February 25

The cooperating hosts for this meeting were the Northern California Section, ACS and Northern California Section of AIChE. Preceded by an excellent buffet supper in the Faculty Club, the group convened for the session at Lewis Hall. ACS Chairman A. C. Nixon, Shell Development Co., introduced AIChE Chairman E. B Chiswell, California Research Corp., and in turn, ASTM Chairman P. V. Garin, Engineer of Tests, Southern Pacific Co., presented the Executive Secretary and President. For ASTM, in addition to Mr. Garin, H. P. Hoopes, District Vice-Chairman, Pabco Products, Inc., handled many responsibilities.

It is the very definite wish of the Southern California group that their Northern California brothers have an active part in the 1956 meeting and this was reviewed following earlier discussions at a council meeting at the Commercial Club, Friday, February 26. It will be noted that a number of the 1956 Committee officers will have come from this area. Former District Chairman T. Parker Dresser, Chief Engineer, Abbot A. Hanks, Inc., continues his constructive activity in both district and national affairs of the Society. Mr. Dresser attended the ASTM nominating committee meeting in Chicago on March 19, the results of which appear elsewhere in this BULLETIN. Many of those who were responsible for successful features of the National Meeting on the Coast in 1949 attended the meetings and are still very active, including L. A. O'Leary, former District Chairman, Head, Chemical Engineering and Research Dept., W. P. Fuller and Co.; and T. K. Cleveland, Chief Chemist, Philadelphia Quartz Co. of California.

One important problem discussed at both the Northern and Southern California Council meetings was membership promotion. Considering the extensive industrial activity on the Coast, it was felt there is room for many more ASTM members, and at the same time members will continue to be stimulated with participation in technical committee matters.

Richland, Wash., Meeting, March 2

After an overnight stop at Portland, Messrs. Beard and Painter went to Richland, Wash., famed for the Hanford plutonium works, and both spoke at what was truly a joint meeting because ASTM has only a few members in this whole area, although there is a good concentration in Portland and the Seattle and Tacoma areas. Past-President T. S. Fuller started a pattern which has been followed the past three years when he was invited to speak before the combined engineering group in Richland at the plant which is being operated by the General Electric Co. for the Atomic Energy Commission. Past-President Maxwell was there just about a year ago, and these visits have been greatly appreciated by the local engineering sections. Those participating in this meeting included the ASME, AIChE, ACS, ASM, and ASTM. The officers were met at the train in Pasco and driven to Richland, had a short tour around this interesting community, and participated

At Southern California District meeting are, left to right: E. O. Bergman, Chairman; President Beard; M. B. Niesley; Secretary R. J. Painter; J. B. Morey, Vice-Chairman.

Photographed at the Northern California District meeting which was held jointly with local sections of the the American Chemical Society and the American Institute of Chemical Engineers, are the local heads of these organizations. Left to right: AIChE Chairman E. B. Chiswell, California Research Corp.; ASTM President Beard; ACS Chairman A. C. Nixon, Shell Development Co.; and ASTM Chairman P. V. Garin, Southern Pacific Co.

in a social period at the local American Legion Club. Following the technical meeting in the Chief Joseph Junior High School, they continued on their way from Pasco to Seattle. This interesting community, which in a very short time mushroomed from two rather small communities into one of probably over 100,000 workmen, engineers, and their families. The concentration of engineering and scientific talent is, of course, very great.

Arrangements for the meeting were made through R. S. Dalrymple, Vice-Chairman of the ASM Columbia Basin Chapter. ACS Chairman H. R. Schmidt acted as a guide during the short day trip; ASM Chairman B. R. Elder opened the technical meeting; ASME Chairman M. W. Carbon introduced the speakers; and finally AIChE Chairman William Harty took the visitors back to Pasco late at night for the train.

Tacoma-Seattle Meeting, Tacoma, Wash., March 4

Through the fine cooperation of two local ASTM members in Seattle, J. W. Sweet, Chief Metallurgist, Boeing Aircraft Co., and Thomas Williams, Co-Partner, Northwest Laboratories, ASTM was invited to take part in the annual joint meeting of engineering groups in Tacoma where the Tacoma Engineers Club was a host. The size of the meeting was a distinct surprise to the visitors, with upwards of 250 present, mostly, of course, members of the AIChE and the ACS, but there was a goodly spattering of ASTM members and committee members. Those who handled this meeting included ACS Chairman Prof. George Cady, University of Washington, Seattle, and in Tacoma, Robert Noble, representing the Chemical Engineers, presided. Marshall Ramstead, Tacoma Chamber of Commerce, representing the Chemical Society; and Arthur R. Anderson, Consulting Engineer, completed the committee. William Smith, Tacoma Engineers Club, presided and opened the meeting. Many came from considerable distance to attend this joint affair.

The Executive Secretary Comments . . .

AT EACH of the eight meetings attended by President Beard and Executive Secretary Painter, the latter spoke briefly. The purpose of his remarks was to greet members and guests and to present a condensed picture of the Society to the many attending these meetings who were not acquainted with ASTM.

He pointed out that ASTM is a horizontal-type organization cutting across most of the professional and materials fields with the result that many of the leading professional and trade groups participate actively in committee work.

The Directors value local meetings not only because they provide an opportunity for members to get better acquanted but also because they assist in stimulating a broad viewpoint of our work and help to overcome a tendency of members to become too confined in specific committee channels.

Industry and Government contribute considerable sums and much time and effort of their technical people in developing about 100 new standards which ASTM turns out yearly. These standards, available in various types of publications, including the big Book of Standards, are very widely distributed. As an example, Mr. Painter referred to the procurement by the Department of State of 100 complete sets of the big Book for overseas distribution.

Reference was also made to the intensified interest in the Department of Defense in coordinating standards, developing a complete product catalog, and improving purchasing and inventory policies.

Demands continue for ASTM work. Some of the new fields under study include reinforced plastic pipe, general industrial microscopy, and synthetic hydraulic fluids. Mr. Painter noted relatively new work undertaken, such as mass spectrometry, atmospheric sampling and analysis (it being carefully noted that this did not include any requirements on air pollution limits), soil conditioners, etc.

In speaking of ASTM research work he showed that this precedes standardization because sound data are necessary to insure satisfactory specifications. The dozens of round-robin projects in committees were noted, and the $150,000 wood-pole research program was cited as a major research activity. The long-time country-wide atmospheric exposure programs are also examples of this work.

The Executive Secretary also provided some vital statistics relative to the Society, referring to the more than 7600 membership total and especially to the some 275 Sustaining Members; and the continuing heavy output of publications including the Special Technical Publications. In 1953, of the total income (just over $800,000), the amount from annual dues for the first time dropped below 30 per cent, heavy publication sales providing over $500,000.

He also spoke of the procurement of expanded headquarters building facilities needed to accommodate a Staff of more than 60 people stating that when the new building is renovated, ASTM will have about $300,000 invested in real estate.

Mr. Painter gave a preview of the 1954 Annual Meeting in Chicago, June 14–18, and the extensive Photographic and Apparatus Exhibits; the two lectures—the Marburg Lecture on "Interpretation of Engineering Data" and the Gillett Lecture on "Endurance Properties of Aluminum."

In closing, the Executive Secretary noted with appreciation what he considered the most important subject of all, namely the continued fine spirit and hard work of the more than 11,000 members and committee members of whom over 50 per cent are active in technical committees.

Large Group Hears President at Detroit District Annual Meeting

THE Annual Meeting of the ASTM Detroit District was held on March 31 at the Engineering Society of Detroit. The technical session featured President L. C. Beard, Jr.'s address, "Something Has Been Added," which has now been presented in a majority of the ASTM Districts. It was followed by a relatively short but animated discussion period. This meeting marks the thirteenth appearance of Dr. Beard before an ASTM audience. Although this was not the largest audience to hear the President it was without question the largest audience at any session sponsored solely by the ASTM. Dr. Beard's talk was preceded by a dinner attended by 200 members and friends of ASTM including about 20 ladies.

Prior to the introduction of the coffee speaker, Detroit District Chairman A. J. Herzig introduced those seated at the head table. In addition to the two guest speakers of the evening and the nine honorary membership recipients or their representatives (see below) Dr. Herzig introduced C. O. Durbin of the Chrysler Corp. and Secretary of the Detroit District; R. B. Saltonstall, The Udylite Corp. and Vice-Chairman of the District; and J. S. Pettibone, ASTM Assistant Technical Secretary, as well as those who had helped make the necessary arrangements for the meeting, namely, O. W. McMullan, Bower Roller Bearing Co., and D. J. McKinnon, Detroit Steel Products Co.

The coffee speaker was ASTM Executive Secretary R. J. Painter who spoke on "Standardization and Materials Research March On." Mr. Painter pointed out that although the 100 new specifications and methods of test sponsored by the technical committees each year may seem small, nevertheless a large number of man hours is represented in the development of these standards. The sale of ASTM books which now amounts to more than one-half million dollars a year is gratifying ,but it is even more interesting to realize that the volume of books sold indicate to a great extent the use and acceptance of ASTM work.

The technical session which was held in the University of Michigan Auditorium in the same building saw between 275 and 300 in attendance. Again Chairman Herzig opened the meeting calling attention to the action taken by the ASTM Detroit District Council to honor certain of the Detroit District members by awarding them honorary memberships in the Detroit District Council. Suitably framed certificates were awarded to each of the recipients. The wording on the certificate was as follows:

"The Detroit District Council of the American Society for Testing Materials recognizes that———————— has served as a national officer of the Society and appreciating his outstanding contributions to its activities in the Detroit Distict hereby appoints him an honorary member of the Detroit District Council with whom, at his pleasure, he may participate in all its meetings and activities."

Nine members of the Council received this award:

F. P. Zimmerli, Chief Engineer for Barnes-Gibson-Raymond, Division of Associated Spring Corp., was awarded the 1947 ASM Sauveur Medal and is at present a member of the ASTM Board of Directors.

C. H. Fellows, Director, Engineering Laboratory and Research Dept., Detroit Edison Co., is a Vice-President of the Society.

T. A. Boyd, associated for many years with General Motors, is a Past-President of the Engineering Society of Detroit and a Past-President of ASTM.

J. H. Foote has served twice on the Board of Directors of ASTM and is at present chairman of the ASTM Administrative Committee on Standards.

A. E. White, associated with the University of Michigan for many years, is a Past-President of ASM and was President of ASTM in 1937.

H. C. Mougey, like T. A. Boyd, found his way to General Motors through the Dayton Metal Products Co. Mr. Mougey is a past national officer.

J. L. McCloud, Ford Motor Co., also is a past officer of ASTM.

W. H. Graves, Vice-President of Engineering of the Packard Motor Car, is also a past ASTM director.

E. W. Upham, Chrysler Corp., has been active in many phases of ASTM work and a past director of the Society.

Messrs. Zimmerli, Fellows, Boyd, Foote, and White were present to receive their certificates personally. The certificates for Messrs. Mougey, McCloud, Graves, and Upham were accepted by C. F. Nixon, General Motors; J. S. Laird, Ford Motor Co.; A. E. Van Deventer, Packard Motor Car Co.; and Don Bigge, Chrysler Corp., respectively.

300 Attend Joint ACS-ASTM Meeting in Wilmington

THE largest of the many audiences which have heard Dr. Beard was the group of 300 ASTM and American Chemical Society members and guests that gathered in Wilmington, Del. (Philadelphia District) on March 17. Dr. Beard's address, "Something Has Been Added," was patterned after the talk he has made in numerous other districts and which appears on page 51 of this BULLETIN. Preceding the technical session more than 120 men enjoyed the social hour and dinner in the Hotel du Pont.

The co-chairmen for the meeting were W. A. Mosher, Head, Department of Chemistry, University of Delaware, and H. L. Maxwell, Technical Adviser, Engineering Department, E. I. du Pont de Nemours and Co., Inc., and immediate past-president of ASTM. Dr. Mosher, in opening the meeting, paid tribute to the ASTM with the statement that, "ASTM in its chemical and technical work can and does help in bridging the gap between the chemist and the chemical engineer."

Dr. Maxwell, prior to introducing President Beard, presented a number of guests including: W. Leonard Hill, Chairman of the Board, Leonard Hill Ltd., Publishers; E. K. Spring, Chairman of the Philadelphia District, ASTM; W. M. Holaday, Director of Socony-Vacuum Laboratories, New York; and R. J. Painter, Executive Secretary of ASTM.

Dr. Beard's talk, which lasted about three-quarters of an hour, evoked a number of questions in the discussion period.

Program co-chairmen for the evening were H. G. Tennent, Hercules Powder Co., representing the ACS, and E. J. Albert, Thwing-Albert Instrument Co., representing ASTM.

Detergent Congress in France

AN International Detergent Congress sponsored by the French detergent manufacturers' trade association, Chambre Syndicale Tramagras, will meet at the Sorbonne in Paris, Aug. 30 to Sept. 5, 1954.

It is expected that the Congress will be divided in four parts: (1) Scientific will cover chemistry and test methods; (2) Technical covers production; (3) Applications covers textiles, leather, furs, and paper, housecleaning, metallurgy, pharmaceutical, dust protection, transportation, food industries, paints and varnishes, construction; and (4) Economics.

Detailed information can be obtained from M. Burté, Directeur, Chambre Syndicale Tramagras, 70 Champs Élysées, Paris, France.

ACR Notes

Printed on behalf of the Administrative Committee on Research.

A thousand requests—actually 1122—for the "ASTM Review of Research" have been received. There can be little doubt of the "outside" interest in the effort that the Society is putting into research through the various technical committees. Some 30 technical journals cooperated by transmitting to the Society requests received for copies of this publication as a result of its availability being announced in technical journals. What is more interesting is the fact that inquiries received came from all over the world as represented by the following 42 countries:

United States 827	Switzerland 3
Canada 29	New Zealand 3
England 23	South Africa 3
Japan 31	Venezuela 2
Argentina 27	Egypt 2
Israel 19	Chile 2
China 17	Portugal 2
Brazil 15	Finland 2
Mexico 15	Cuba 2
Philippines 10	Australia 2
Germany 10	Puerto Rico 1
Italy 10	Jamaica 1
Belgium 9	Fr. West Africa 1
Netherlands 9	Thailand 1
Sweden 8	Greece 1
Spain 7	Iceland 1
France 6	Palestine 1
Yugoslavia 5	S. Wales 1
Peru 4	Lebanon 1
India 3	Czechoslovakia 1
Turkey 3	Ecuador 1
	Trinidad 1

First issued last month, "ACR Notes" will contain from time to time letters which it is believed will be of interest to the general ASTM membership. One such letter follows and although submitted by an active ASTM member, the author has preferred it signed as a Member.

"Dear Mr. Voss:

"The pamphlet 'Some Unsolved Problems' had been examined with interest.

"Evaluative studies or researches on materials characteristics are a majority among those problems listed in the compilation. They certainly come within the purpose 'Promotion of knowledge of the materials of engineering.' The over-all record of Society accomplishment in this area has been splendid. There are several 'stumbling blocks' encountered. Recognition of one such 'block' and effort to compensate is considered under 'Simulated Service Testing.' What seems to be an especially difficult field is that of comparisons of materials of different 'families,' such as—say metals *versus* plastics. There are some occasions where over-enthusiasm and perhaps competitive pressures make it difficult to get valid and objective relative evaluations of even closely related materials. There also is a natural tendency to over-simplify evaluative procedures disregarding the limitations of many of our common tests to serve as 'guarantees' of service performance.

"The first listed problem 'Mechanism of Stress Corrosion Cracking' illustrates another type of research. Understanding of the 'whys' is fundamental toward advancement. The field is one where there is common interest. Despite the appropriateness of this and similar problems, it often is difficult to get much support for so-called fundamental research.

"I am not going to presume to list the many research problems of which many members of the committee are cognizant, but I would like to suggest that the technical committees apparently have not gone very far in placing their problems before your group. Would it not be possible for the several committees to prepare for your group statements of research status and gaps? Such statements would include condensed summarizations of the status, suggestions on direction or guided future, and title outlines of 'problems' both current and desirable to undertake in the future. In other words, review and recommendation.

"It is recognized that this may be 'extra work' for some standing committees. One of the ever present 'duties' of every group in the Society is promotion of wider interest both within the membership and before the public. A little shift in approach, along general lines indicated above, may add to the effectiveness of your already valuable presentation.

"I am enclosing a very partial list of some problems I would like to have answered, and on which our data and that of the literature is inadequate.

"1. Relationships of gas content to fluidity and feeding of tin bronzes. (End point, improvements in density.)

"2. Structural stability at moderately elevated temperatures in the silicon bronzes and the silicon brasses. These are 'age hardening' and some are prescribed dangerously.

"3. Mechanics of ductility losses experienced in stress rupture at elevated temperatures of certain low alloy steels. More evaluative data on this phenomenon.

"4. The states of vanadium in low alloy steel, the relationships of its associations to elevated temperature properties, and means of checks and controls thereof.

"5. The relationships of the shifting of the stress axis from the geometric axis (longitudinal, in cylindrical shapes) different compositions and microstructures of gray iron."

Signed,
A MEMBER

Comments concerning the content of this column would be appreciated and should be addressed to the Secretary, Administrative Committee on Research, ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

Electrolytic Molybdenum

SUCCESSFUL electrolytic preparation of molybdenum—a critical refractory metal for high-temperature applications—has been achieved at the National Bureau of Standards. The experiments have produced high-purity molybdenum by electrolysis of a bath of fused salts. The process is very flexible and easily controlled; depending on the conditions of electrolysis, deposits vary from fine powders, to thick, coherent layers. With further development of the process, electroforming of molybdenum objects may become feasible. More rapid, less expensive methods for producing molybdenum parts and coatings and for extracting the metal from the ore may result from this work.

In recent years the need for heat-resistant materials in various applications has stimulated interest in refractory metals such as tungsten and molybdenum. At present molybdenum is produced chemically as a fine powder by reducing purified molybdic oxide with hydrogen. However, the process is expensive and has a number of other disadvantages. The molybdenum is obtained as a very fine powder, and the size of the particles cannot be controlled. Because of the fineness of the powder, a large surface area is exposed to oxidation; extensive purification is thus required. Complicated powder-metallurgy procedures are also necessary to fabricate the powder into molybdenum objects.

These disadvantages may be eliminated by the electrolytic method as the deposits are obtained directly on the cathode in the desired physical form and in a very pure state. Applications of the method for electrowinning, electrorefining, electroforming, and electroplating are under study. Electroforming would make possible the formation of molybdenum parts having complicated shapes. Molybdenum electroplating would have the advantage of conserving this critical metal and at the same time allowing the designer to take advantage of the properties of the basis metal.

Corrosion Engineers Elect

AARON WACHTER has been elected president; F. L. Whitney, Jr., Kansas City Conference Technical Program Chairman, vice-president; and Russell A. Brannon was re-elected treasurer, for the 1954–1955 term which began the last day of the Tenth Annual NACE Conference at Kansas City, March 15–19.

Technical Committee Notes

Concrete

Report on Cooperative Tests for Potential Volume Change and Abnormal Expansion of Cement-Aggregate Combinations

THE chemical reactions of aggregate in concrete, as well as the effect of certain cement-aggregate combinations, has been a subject of much discussion and research in Committee C-9 on Concrete and Concrete Aggregates. The failure of many concrete structures and pavements has been due, it is felt, to a great degree to the reaction which has taken place within the concrete due to the chemical reactivity of certain cement-aggregate combinations. Subcommittee II-b on Chemical Reactions of Aggregate in Concrete, under the chairmanship of W. C. Hanna, has attempted to evaluate the various characteristics through cooperative tests in order to establish a method of test which would aid in classifying the many cement-aggregate combinations that can be used in concrete.

The final report on a cooperative test series has been completed, presenting considerable data from which a proposed tentative method of test for potential volume change and a test for potential abnormal expansion of cement-aggregate combinations has been developed. Six laboratories participated in the cooperative tests, using three cements supplied by the Bureau of Reclamation. Aggregates selected for use consisted of gravel and sand from two sources and representing a range in reactivity to both high and low-alkali cements. Mix design data were developed in the engineering laboratories of the Bureau of Reclamation.

The data listed in the report enabled the subcommittee to agree upon the proposed method for determining potential volume change, but, due to poor reproducibility of results, the proposed method for potential abnormal expansion was not approved at this time. The complete report will be published as an appendix to the 1954 Annual Report of Committee C-9, appearing in the 1954 Annual *Proceedings*.

Committee D-5 Participates in Third Meeting of ISO Technical Committee, London

ASTM Group Designated Official Representatives

THE American Standards Assn. as the American member of Technical Committee 27 on Solid Mineral Fuels of the International Organization for Standardization, looks to ASTM Committee D-5 on Coal and Coke for active participation. ISO/TC 27 is now engaged in the preparation of international standards for sampling, analysis, and testing of coal, and is seeking to coordinate, as far as possible, the various national standards of the participating nations.

The Coal Committee of the Economic Commission for Europe encountered difficulties with regard to European coal requirements because of differences in methods of analysis and testing from country to country. Therefore, the committee considered that international agreement on methods of testing and analysis of coals should be dealt with as a matter of urgency, and referred this task to ISO Technical Committee 27.

The first meeting of ISO/TC 27 was held in March, 1950, and a second meeting in December, 1951. No American representative was present at the first meeting, but the second meeting was attended by W. A. Selvig of the U. S. Bureau of Mines as the sole representative from the United States.

American Delegation

The third meeting of ISO/TC 27 was held at the British Standards Institution, London, England, Nov. 2–10, 1953. Because the agenda was so comprehensive that it would not have been possible for one delegate to represent the United States adequately at all sessions, three members of ASTM Committee D-5 were sent as delegates to this meeting: W. A. Selvig (Leader), Chief, Coal Constitution and Miscellaneous Analysis Section, U. S. Bureau of Mines; O. W. Rees, Head, Analytical Division, Illinois State Geological Survey; and W. M. Bertholf, Efficiency Engineer, The Colorado Fuel and Iron Corp.

Selection of Mr. Selvig as the leader of the American delegates recognized his 32 years of service as secretary and chairman of Committee D-5 on Coal and Coke; his active participation since 1949 in the work of the Classification Working Party, Coal Committee, Economic Commission for Europe; and his previous experience as a delegate to the second meeting of ISO/TC 27.

Mr. Rees was selected as one of the American delegates because of his intimate knowledge of coal analysis and because he is at present chairman of Subcommittee XXI on Methods of Analysis of ASTM Committee D-5.

Mr. Bertholf was selected as the third American delegate because of his experience in the statistical treatment of coal sampling data, and his active participation in the work of Commiteee D-5's Subcommittee XIII on Coal Sampling.

This third meeting was attended also by representatives of the following nations: Belgium (3), Denmark (1), France (9), Germany (4), India (3), Italy (5), Netherlands (3), New Zealand (1), Spain (3), Sweden (1), United Kingdom (7). Observers were present from the International Gas Union and the Coal Classification Working Party of the Economic Commission for Europe.

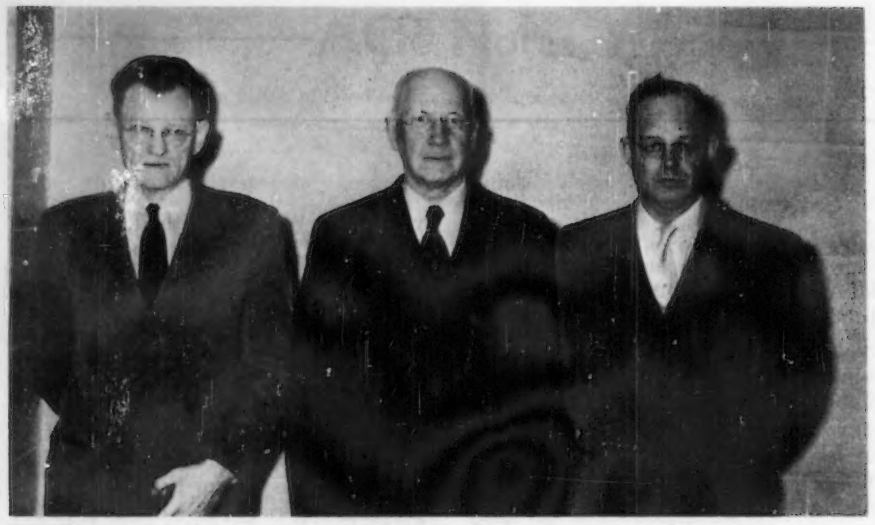
Fourteen Tests Considered

The agenda for this meeting included consideration of the following tests: moisture, gross calorific value, carbon and hydrogen, total sulfur, nitrogen, swelling and caking, phosphorus, chlorine, arsenic, forms of sulfur, mineral matter, ash, volatile matter, and sampling.

Each of these tests was discussed in detail, and numerous resolutions were made on points of agreement. Working groups on moisture, ash, and sulfur were formed to investigate these procedures, particularly the points of disagreement.

A report was made of the meeting of the working group on volatile matter, held at the Fuel Research Station, London, April 13–16, 1953, at which meeting the United States was represented by R. F. Abernethy of the Pittsburgh Experiment Station, U. S. Bureau of Mines.

The British Standards Institution,



Committee D-5 delegates to the London meetings of ISO/TC 27 are, left to right: O. W. Rees; W. A. Selvig, and W. M. Bertholf.

which is the Secretariat of ISO/TC 27, was instructed to prepare drafts of the methods which had reached the proposal stage of agreement.

Messrs. Selvig and Rees attended all sessions of the committee, and Mr. Bertholf attended the sessions on coal sampling. At one of the sessions on coal sampling, Mr. Bertholf presented a summary of the current status of thought in the United States on the statistical approach to the coal sampling problem in a paper titled "The Trend Theory in Coal Sampling."

In addition, he attended four special conferences arranged through the mutual efforts of the British Standards Institution, the British National Coal Board, and the British Coal Utilization Research Assn. These special meetings were attended by coal sampling experts from the other nations, and were under the guidance of R. C. Tomlinson of the British National Coal Board.

Opportunities were also afforded for visits to research laboratories in the London area which were planned to permit the delegates to see some of the equipment and procedures being used for analyzing coal at these British research stations.

Extensive Interchange of Data

The American delegates were impressed by the sincerity of the attending delegations, and their willingness to cooperate and compromise. This sincerity of purpose is evidenced by the enormous amount of research work on methods of analysis which has been and is being done by the participating nations in an effort to secure international standards based on the best scientific thought and practice of the various nations cooperating in the work of ISO/TC 27. As Secretariat of ISO/TC 27, the British Standards Institution acts as the liaison agency for all of this research, and to date almost 200 documents on methods of analysis and research have been distributed to the members of ISO/TC 27. Approximately 150 of these documents have been distributed to the various subcommittees of ASTM Committee D-5 for their consideration, and about 40 more documents are in process of reproduction for similar distribution.

As a result of participation in the work of ISO/TC 27, ASTM Committee D-5 has been afforded access to much information and data which would otherwise not be so readily available to the committee. The mental stimulus has been tremendous, and the tempo of activity of Committee D-5 has increased accordingly. The committee has already undertaken the review of numerous methods under its jurisdiction, and, as a result of participation in the work of ISO/TC 27, almost all of the ASTM methods on coal will require review.

Moreover, several new ideas on methods of test not now recognized, or which have never been considered by Committee D-5, are under discussion by ISO/TC 27, and may lead to additional standard methods of test which can be accepted by ASTM.

Meetings of some of the working groups of ISO/TC 27 are being tentatively planned for the end of 1954 or early in 1955, and Committee D-5 has agreed to cooperate in the work of some of these special groups.

Adhesives

Specifications for Compreg Developed

COMPREG is one of the modified wood and wood-base materials which have increased in usage and variety over the past few years. The first effort to establish standards governing their quality was reported at the meeting of Committee D-7 on Wood held at the Palmer House in Chicago, Ill., March 15 and 16. A tentative specification was accepted, subject to letter ballot of the committee, which will set up limits for such materials and products. The test methods applicable are those already established and published by the Society.

One other new tentative accepted was a specification for Chemonite (ammoniacal copper arsenite). This new specification will add to the comprehensive list of wood preservative specifications now published by the Society. Its acceptance is conditional on approval by the Board of Directors, because the material covered is of a patented nature.

Further revisions were accepted of the Tentative Specification for Round Timber Piles (D 25), which it is hoped will complete the current review of this important specification and will lead to its adoption as a full standard in another year. Revisions are in process of the Tentative Methods for Establishing Structural Grades of Lumber (D 245), with the expectancy that recommendations will be accepted at the next meeting of the committee.

An important report presented was that of the Subcommittee on Wood Poles and Crossarms. This subcommittee's activities include supervision of the ASTM Wood Pole Research Program. The first progress report covers the actual inauguration of the testing program conducted at the U. S. Forest Products Laboratory. Poles of two species, western larch and southern yellow pine, have been tested using the machine or hydraulic testing method. Slides were shown of the initial field selection of poles in both the Montana-Idaho area and South Carolina, as well as views of the initial testing at the Forest Products Laboratory. It was agreed that activity should be reopened in the preparation of test methods for crossarms and that there would be no attempt to prepare specifications at this time.

The newest subcommittee, Subcommittee XV on Structural Fiber Boards, has agreed upon a scope of operation: "Nomenclature, definition of products, specifications, methods of test, and related subjects pertaining to the mechanical properties of reconstituted boards

derived wholly or in part from lignocellulosic materials." Two task groups were formed, one to study nomenclature and definitions and the other to make a survey of procedures needed for evaluating fiberboards.

At its next meeting in 1955, the committee plans a special celebration of its 50th anniversary. This meeting will be in Chicago at the time of the AREA meetings in March. A memorial in honor of Dr. Hermann von Schrenk, long-time chairman of the committee and past-president of the Society, was read and adopted.

Electrical Insulating Materials

Annual Meeting Symposium Arrangements Completed at Three-Day Meeting

PLANS for the comprehensive Symposium on Temperature Classification of Insulating Materials were completed at the meeting of Committee D-9 held on March 24 to 26 in Roanoke, Va. This symposium to be held at the forthcoming Annual Meeting will comprise ten technical papers which will present extensive up-to-date information and data on the thermal properties of a variety of electrical insulating materials, including information on heat aging and stability and on dielectric characteristics of various materials including silicones, mica products, varnished cloth and tape, polyvinyl chloride compounds, thermosetting materials, etc. It is hoped that as a result of the information to be made available by the symposium, new test methods for determining thermal stability and high-temperature characteristics of electrical insulation will be developed.

Over the three-day period, meetings were held of 10 subcommittees at which actions were taken on a number of new and revised methods and specifications.

A group of new test methods have been completed for the newer silicone varnishes. These cover procedures for specific gravity, viscosity, flash point, nonvolatile matter by weight, and dielectric strength.

The **Subcommittee on Molded Materials** recommended adoption as standard of existing tentative revisions in the Standard Methods of Testing Sheet and Plate Materials Used in Electrical Insulation (D 229), Methods of Testing Laminated Round Rods Used for Electrical Insulation (D 349), and Methods of Testing Laminated Tubes Used for Electrical Insulation (D 348). In the latter two methods there will be included statements covering the significance of tests. Revision was recommended of the Tentative Methods of Testing Molded Materials Used for Electrical Insulation (D 48) to require the use of flat washers in place of cupped washers in preparing the test specimen for the insulation and volume resistance test.

Three methods developed by the **Subcommittee on Insulating Oils** have been approved by letter ballot of Committee D-9. These cover a new Test for Water in Insulating Oils by Extraction designed to measure the amount of water contained in transformer oil or other high boiling oils and two methods covering procedures for determining sludge formation representing revision and separation of the present procedures A and B in Method D 670. The Test for Sludge Formation in Mineral Transformer Oil by High-Pressure Oxidation Bomb (formerly Method B) is to be published as standard. This test determines the "bomb sludge value" which is the percentage by weight of sludge formed after 24-hr oxidation at 140 C under 250 psi of oxygen pressure. The companion method (formerly Method A), which is to be published as tentative, is a Sludge Accumulation Test which evaluates the propensity of an oil to deposit a nonsoluble sludge under definitely prescribed conditions of oxidation in the presence of a copper catalyst for 72, 168, and 336 hr.

Revisions were presented in the Tentative Methods of Testing Electrical Insulating Oils (D 117) comprising definitions and statements of significance of tests for water and saponification number of insulating oils. It was also recommended that the test cells for measuring power factor and dielectric constant of insulating liquids which have appeared in Appendix III of the Tentative Methods of Test for Power Factor and Dielectric Constant of Electrical Insulating Materials (D 150) be appended to the Method of Test for Power Factor and Dielectric Constant of Electrical Insulating Oils of Petroleum Origin (D 924) and the Tentative Method of Test for Insulation Resistivity of Electrical Insulating Oils of Petroleum Origin (D 1169).

Based on results of a questionnaire on current usage of the Methods of Testing Solid Filling and Treating Compounds Used for Electrical Insulation (D 176) studies are continuing of the various test procedures covered in order to bring them up to date and add any new methods.

The **Subcommittee on Insulating Fabrics** is giving consideration to methods and specifications for additional varieties of varnished cloth and fabrics including nylon, silk, and silicone rubber glass tapes. Revisions are being undertaken of Specifications and Test Methods for Black Bias-Cut Varnished Cloth and Tape (D 377 and D 295).

The Tentative Methods of Testing Pressure-Sensitive Adhesive Tapes Used for Electrical Insulation (D 1000) have been under active review and study by the Section on Electrical Adhesive Tapes. This section has held two meetings, each of two days duration. Items under study cover electrolytic corrosion, thickness measurements, breaking strength and elongation, wet dielectric strength, adhesion measurements, penetration test and storage stability of elasto plastic tapes, thermal reaction rate and solvent resistance of thermosetting tapes, tack or quick grab tests for all types of tapes.

A. G. Ashcroft (left), Vice-President and Director of Research and Development, Alexander Smith, Inc., receives the H. De Witt Smith Memorial Medal from Chairman W. D. Appel of ASTM Committee D-13 on Textiles. The award to Mr. Ashcroft was made at a luncheon held in New York City March 18, during the Spring meeting of the Textile Committee.

A draft of proposed specifications for capacitor tissue was given thorough review by the Subcommittee on Insulating Paper and certain changes are under study. A revision of the test for wet strength in the Tentative Specifications for Absorbent Laminating Paper for Electrical Insulation (D 1080) is under letter ballot in the subcommittee.

Exceptional progress was made at the meeting of the **Subcommittee on Mica Products** in reaching agreement on a set of visual reference standards for grading natural muscovite mica based on visual quality in accordance with Tentative Specifications D 351. A set of Master Standards of Waviness, which represent the full range of wave variations for visual quality levels of Good Stained and better in the ASTM visual quality classification, is now available for reference at ASTM Headquarters. The committee had previously selected samples of mica from various sources for grading other characteristics. Agreement has now been reached on a composite set of samples of block mica representing the full range of visual variations for each quality level. When completed, these reference standards will be available for use at Society Headquarters.

The Tentative Specifications for Natural Block Mica and Mica Films Suitable for Use in Fixed Mica-Dielectric Capacitors (D 748) were recommended for adoption as standard, as was also the Tentative Revision of the Standard Method of Test for Power Factor and Dielectric Constant of Natural Mica (D 1082).

An extensive revision of the Tentative Methods of Test for Electrical Resistance of Insulating Materials (D 257) was completed and approved for committee letter ballot. An extensive revision of the Methods of Test for Dielectric Strength of Electrical Insulating Materials at Commercial Power Frequencies (D 149) was also completed and will be submitted to vote of the Subcommittee on Electrical Tests. Action was taken to appoint a new section to develop ionization or corona tests for electrical insulating materials. A revision of the Standard Methods of Conditioning Plastics and Electrical Insulating Materials for Testing (D 618) was approved. Important revisions were also recommended in the Tentative Specifications for Enclosures and Servicing Units for Tests above and below Room Temperature (D 1197). These cover changes in the requirements for time constant, temperature fluctuation, temperature differential, and temperature drift.

Soaps and Detergents

A Number of New Methods Under Preparation

COMMITTEE D-12 on Soap and Detergents held its annual meeting on March 22 and 23 at the Park-Sheraton Hotel in New York City. At this time the work of the committee during the past year was reviewed, several papers were presented, and recommendations were acted upon for various new and revised items to be submitted to the Society for acceptance. It is expected that the papers will be published later this year. The various recommendations for submittal to the Society will be covered in more detail in the report of the committee to be preprinted shortly, but are enumerated below according to the subcommittees responsible for them.

Subcommittee T-1 is currently developing methods of test for sodium chloride, copper, and phosphorus pentoxide in soap. Of these three tests, the committee expects to recommend the publication of the copper method as tentative this year.

Subcommittee T-2. Procedures for the qualitative analysis of synthetic detergents are in process of preparation. A solvent method for determination of active ingredients is also under study. A task group is developing a method for obtaining reproducible infrared spectrograms of synthetic detergents. The subcommittee is particularly hopeful that the infrared methods will provide a tool for identifying components of synthetic detergents that otherwise are identifiable only by more difficult and time-consuming means.

Subcommittee T-3 is working on methods of test for percentage of moisture, total nonvolatile matter, and flash point for dry cleaning materials.

Subcommittee T-4 is presenting revisions in the methods for sampling and chemical analysis of alkaline detergents so that these methods will also cover the testing of sodium orthosilicate.

Subcommittee T-5 is recommending the publication as tentative of the methods of test for surface and interfacial tension of solutions of surface-active agents, which were published as information in 1952. Also approved were extensive revisions of the method of test for pH of aqueous solutions of soaps and detergents (D 1172 – 51 T) to increase the coverage of the method to include determinations of pH of soap solutions that gel at the present test temperature. The subcommittee is intensively studying the problems of wetting tests and of tests for redeposition of soils, with a view toward development of standardized test methods.

Subcommittee T-6 is developing a test for corrosivity of detergents with respect to vitreous enameled surfaces. Also under study are problems relating to the use of detergents in the automotive industry.

Subcommittee T-7 was newly organized to cover the over-all coordination of work on sampling and interpretation of data in Committee D-12.

Subcommittee S-4 is preparing specifications for sodium orthosilicate and sodium metasilicate.

Plastics

Committee Work to Include Reinforced Plastics and Plastic Pipe

OF outstanding significance was a decision reached at a recent meeting of Committee D-20 on Plastics to expand the committee's activities to include the development of specifications and test methods for reinforced plastics and for plastic pipes and fittings. It was also decided to expand the current work on thermoplastic materials and on thermosetting materials. It is planned to establish the following five new subcommittees on these subjects: XV on Thermoplastic Materials, XVI on Thermosetting Materials, XVII on Plastic Pipe and Fittings, XVIII on Reinforced Plastics, and XIX on Plastic Films and Sheeting. With the organization of these new subcommittees the present Subcommittee VI on Specifications will be disbanded.

This work will be carried on in cooperation with the Society of the Plastics Industry. A meeting of the officers of Committee D-20, and representatives of SPI and ASTM is being held late in April in order to complete the details of organization.

One evening of the committee's meeting was devoted to a technical session. Technical papers were presented by F. W. Reinhart who described an investigation of the use of a fluorescent lamp in lieu of the present S-1 sun lamp in the laboratory accelerated testing of plastics; Lucius Gilman presented the results of a very intensive investigation on the outdoor weathering in several types of exposure of a large number of plastic materials; and B. L. Lewis discussed the use of servo-mechanisms. In ad-

dition, a panel discussion was held with respect to the statistical planning of experiments and the use of statistics in analyzing results. This panel discussion was led by C. R. Stock, C. H. Adams, and C. L. Mantell.

The **Subcommittee on Strength Properties** presented five recommendations for committee letter ballot. These included revisions in the Tentative Methods of Test for Tensile Properties of Thin Plastic Sheets and Films (D 882) and for Impact Resistance of Plastics and Electrical Insulating Materials (D 256).

An important revision of the Tentative Method of Test for Brittleness Temperature of Plastics and Elastomers by Impact (D 746) is now under letter ballot vote in the committee. The revisions to be included will make the method more satisfactory not only for testing plastics but particularly for testing automotive rubber and other elastomers. The results of the current vote on the Tentative Method of Test for Molding Index of Thermosetting Molding Powder (D 731) are favorable and this revision will be included in the Annual Report to the Society in June.

The **Subcommittee on Permanence Properties** recommended the adoption as standard of three tentative methods which cover Volatile Loss from Plastic Materials (D 1203), Measurement of Changes in Linear Dimensions of Nonrigid Thermoplastic Sheeting or Film (D 1204), and Resistance of Plastic Films to Extraction by Chemicals (D 1239). The committee decided to recommend to the Society in June the withdrawal of the present Tentative Methods of Test for Weight Loss of Plastics on Heating (D 948) and for Water Vapor Permeability of Plastic Sheets (D 697).

The **Subcommittee on Specifications** recommended the adoption as standard of the Tentative Specifications for Polyethylene Molding and Extrusion Materials (D 1248), and for Primary Octyl Phthalate Ester Plasticizers (D 1249). Revisions were presented in the Tentative Specifications for Phenolic Molding Compounds (D 700).

The requirements for the transfer mold shown in Fig. 6 of the Tentative Specifications for Molds for Test Specimens of Plastic Molding Materials (D 647) will be removed. Action was also taken to recommend the withdrawal of the Tentative Recommended Practice for Transfer Molding of Specimens of Phenolic Materials (D 1046).

The **Subcommittee on Nomenclature and Definitions** submitted some additional definitions of terms for inclusion in the Tentative Definitions of Terms Relating to Plastics (D 883). Letter ballot will also be taken on the proposed revisions of the Descriptive Nomenclature of Objects Made from Plastics (D 675).

Recommendation was made to both Committee D-20 and Committee D-9 that the Recommended Practice for Maintaining Constant Relative Humidity by Means of Aqueous Solutions (D 1041) be placed under the jurisdiction of Committee E-1 on Methods of Testing. This recommended practice is intended for general use for obtaining constant relative humidities in the range from 30 to 90 per cent at temperatures from 0 to 70 C in relatively small containers.

Draft of a Proposed Tentative Specification for Non-Rigid Polyvinyl Chloride or Copolymer Molding and Extrusion Compounds was submitted as a revision and consolidation of the present Specifications D 742 and D 744. These specifications cover the general classification of nonrigid plastics in which the resin portion of the composition contains at least 90 per cent vinyl chloride. The remaining 10 per cent may include one or more monomers copolymerized with vinyl chloride or consist of other resins mechanically blended together with polyvinylchloride.

Emission Spectroscopy

Progress Reported in Development of Standard Samples

COMMITTEE E-2 met on March 4, at the William Penn Hotel in Pittsburgh. Progress was reported on the development of urgently needed additional standard samples, particularly of spectroscopic standards for steels. Sources of such standards as may become available in the near future will be given in the new edition of the "Report on Standard Samples for Spectrochemical Analysis" which is now in preparation and should be completed later this year. It was also reported that the standardization of sizes and shapes of carbon electrodes is progressing well.

The committee is continuing to concentrate its efforts on the preparation of tentative methods, using as the basis for this work the suggested methods published in 1953 in the book on "Methods for Emission Spectrochemical Analysis." Prospects were stated as being good for the advancement to tentative status of methods for analysis of nickel, lead, tin, aluminum, and zinc. Considerable progress was reported on preparation of methods for spectrochemical analysis of steel and cast iron.

In the field of nonmetallic materials, there is still considerable activity in the compilation of suggested methods, although some work is already under way on the preparation of tentative methods for nonmetals also. At the present time, fourteen proposed suggested methods are under consideration in the committee.

To ASTM Members: Your help is needed in maintaining that constant increase in ASTM Membership

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To the ASTM Committee on Membership,
1916 Race St., Philadelphia, 3, Pa.

Gentlemen:

Please send information on membership to the company or individual indicated below:

_____

_____

This company or individual is interested in the following subjects: indicate field of activity, that is, petroleum, steels, non-ferrous, etc.

_____

Signed _____

Date _____ **Address** _____

Absorption Spectroscopy

Work on Infrared Index Cards Completed

On March 5 and 6, meetings of Committee E-13 on Absorption Spectroscopy and its subcommittees were held in the William Penn Hotel, Pittsburgh, Pa. While substantial progress was reported on a number of projects, the most significant accomplishment reported was the completion of the work of the committee on the current deck of IBM infrared index cards, now being distributed by the Society. It was also reported that the first deck of IBM ultraviolet index cards will be ready for distribution very soon.

The committee approved a standard form for empirical formula compound index cards, with the recommendation that decks of such cards be distributed by the Society when they are available.

Consideration was given to the performance tests for apparatus that are most urgently needed for proper definition of apparatus requirements in absorption spectroscopy. Considerable progress was reported on development of a method for evaluation of resolution of spectrometers.

A number of proposed standard definitions of terms were considered. As a continuing project, the committee plans to work on the development of standard definitions of all of the more important terms in absorption spectroscopy. In this project, Committee E-13 will work with the joint Committee on Nomenclature in Applied Spectroscopy, established by the Society for Applied Spectroscopy and ASTM.

Boiler Feedwater Studies

Report of Joint Research Committee Activities for 1953

This committee, sponsored by American Boiler Manufacturers Assn. and Affiliated Industries, American Railway Engineering Assn., American Society for Testing Materials, American Society of Mechanical Engineers, American Water Works Assn., and Edison Electric Institute, continued its previous activities throughout 1953 with some intensification of effort, but without any major changes in policy. These activities include continuous review of developments and problems in assigned areas of study by the technical subcommittees; sponsorship of technical programs at appropriate society meetings; preparation for financial support and direction of research in areas where there is critical shortage of information; and continued advice for research projects seeking the committee's assistance. All activities are directed by the committee, which consists of two representatives from each of the six sponsor societies, one representative from the U. S. Navy, and the officers and immediate past officers (who may not otherwise be members of the committee).

Subcommittee Activities

The subcommittees are all at work under capable chairmen. All meet at the time of the year-end annual meeting of the committee and are free to carry on their affairs either by correspondence or by additional meetings, as best suits their separate needs, between these times.

Deposits Subcommittee—A. A. Berk, chairman.

The subcommittee is keeping close and comprehensive watch on developments in its field of interest and is assisting in the solicitation and presentation of informative papers. Each member is assigned a portion of the area of concern to the subcommittee for individual study and periodic report to the group.

Steam Contamination Subcommittee—R. A. Lorenzini, chairman.

Prime concern has been initiation of the research program on iron oxide deposits on high-pressure-steam, stop-valve stems. The program has been detailed and discussed with research institutions so that a contract can be negotiated as soon as funds are available. A summary of the problem has been prepared for the Finance Committee, and a steering committee for direction of the research project has been organized. The bibliography on steam contamination has been published by the ASME, as has been the compilation of papers on the subject presented at the 1951 Annual Meeting of ASME. Close attention has been given to the private research on sampling of evaporator vapor under the direction of E. B. Morris, a member of the subcommittee.

Corrosion Subcommittee—J. W. Ryznar, chairman.

The subcommittee has completed all preparations so that as soon as the

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To the ASTM Committee on Membership
1916 Race St., Philadelphia 3, Pa.

Gentlemen:

Please send me information on Membership in ASTM and include a membership application blank.

Signed_____

Address_____

Date_____

Finance Committee can provide the funds their research program can be started. This is to be a carefully planned study of the equilibria between iron and boiler water in the range up to the critical temperature and pressure. Review of technical studies, reports, and papers in the corrosion field has continued. Considerable assistance also has been given toward committee-sponsored sessions, as mentioned below.

Technical Paper Program

A total of eight sessions of technical papers were held during the year, either sponsored or jointly sponsored by the committee.

The first session was at the American Power Conference, and was arranged by the Water Technology Committee of the Conference. Two sessions were held at the Semi-Annual Meeting of the ASME in Los Angeles. These were arranged for the committee by Scott Jensen. The committee also participated in two sessions at the September meeting of the American Chemical Society, under the chairmanship of A. A. Berk. A committee-sponsored session at the Water Conference of the Engineer's Society of Western Pennsylvania in October was provided by the Conference committee. The committee was involved in two sessions of the ASME annual meeting, jointly sponsoring one session arranged by the Power Division, and taking full charge of the other. The latter was organized by H. A. Grabowski of the Corrosion Subcommittee. At each of the meetings in which the committee sponsored sessions, one of the officers presented a report of committee progress and plans.

A similar extensive program has been planned for 1954.

Finances

Coordinating the requests and plans of the subcommittees, soliciting the approval of the six sponsor societies, and preparing for a fund-raising campaign developed into more of a task than one volunteer (this work is in charge of the second vice-chairman) should be asked to perform. Accordingly, a Finance Committee is being organized to assume continuing responsibility for this portion of the committee's activities.

Virtually all necessary approvals for the committee's expanded program have been obtained. The Finance Committee now is preparing for the fund-raising campaign, which it is expected can be started early in the coming year. E. P. Partridge has accepted the chairmanship of the Finance Committee, and the second vice-chairman will serve as an *ex-officio* member.

General Activities

Although activities of the committee are continuously increasing, the general program and method of operation remain unchanged. With frequent addition of subcommittee members and occasional changes of sponsor representatives, it is desirable to have a guide to responsibilities and procedures for these new members. However, there is a risk of impairing the currently fruitful informal association and versatility of the committee if formal by-laws are adopted. Therefore it is planned to issue an outline of normal duties and procedures for the information of all members.

The custom since World War II has been to advance the two vice-chairmen at each biennial election, electing at that time a new second vice-chairman. The secretary then is appointed by the new chairman. In accordance with this practice, the officers for 1954–55 are:

Chairman—R. C. Adams
First Vice-Chairman—P. B. Place
Second Vice-Chairman—M. D. Baker
Secretary—E. A. Pirsh

Mr. Adams, Superintendent of the Chemical Engineering Laboratory, U. S. Naval Experiment Station, Annapolis, Md., and vice-chairman of ASTM Committee D-19 on Industrial Water, became Navy representative on the Joint Committee in 1933 and has served continuously ever since.

Corrosion Exhibition in Norway

THE Norwegian Industries Development Assn., in cooperation with other scientific and industrial research institutions is organizing an international exhibition and conference in Oslo from June 11 to 20 this year. Within the scope of the motto "Against Rust and Rot" the exhibiton will be a review of methods and products for the protection of metals, concrete, and wood.

The exhibition will comprise a general display, in which the various forms of corrosion and the types of wood and concrete decay will be shown, and where, if possible, the factor of cost that corrosion and rot represent in the national economy, is demonstrated. A conference will be held during the exhibition with lectures by foreign and Norwegian experts. The conference aims to render a greater understanding of the problems and to promote positive suggestions for their solution.

During the first two days subjects of general interest will be covered and on the last 2 to 3 days short clinics on the practical applications of methods and means for protection will be held.

"Hot" Papers Wanted

WITH the advent of the jet era, the growing use of gas turbines, and the increasing demand for materials able to withstand higher and higher temperatures in steam turbines, technical men in the elevated-temperature field have been hard pressed to keep abreast of current developments.

Recognizing the necessity of collating and disseminating the newest data on heat-resisting materials, the General Research Panel of the ASTM-ASME Joint Committee on Effect of Temperature on the Properties of Metals is sponsoring or co-sponsoring, within the next 18 months, three symposiums.

A "Symposium on Metallic Materials for Service Above 1600 F" is planned for the 1955 ASTM Annual Meeting in Atlantic City the week of June 26. As one might expect from the title of this symposium the materials usable for applications above 1600 F are considerably different from the heat-resisting metals of, say, ten years ago. One example of the newer type of materials is the cermets. The committee for this symposium would welcome offers of papers or any suggestions concerning the nature of the program. Closing date for receipt of offers of papers is October 30, 1954. Manuscripts should be available by March 1, 1955. The chairman of this symposium committee is V. H. Krivobok, International Nickel Co., 67 Wall St., New York 5, N. Y.

More imminent is the "Symposium on Basic Effects of Environment on Strength, Scaling, and Embrittlement of Metals at Elevated Temperatures," scheduled for the 1955 ASTM Committee Week in Cincinnati the week of January 31. The closing date for receipt of offers of papers for this symposium is also October 30, 1954, but manuscripts must be submitted by December 31, 1954. The chairman of the committee developing this symposium is Evan A. Davis, Adv. Engr., Mechanics Department, Westinghouse Electric Corp., East Pittsburgh, Pa.

Both of the above sessions are in the planning stage and are the sole responsibility of the Joint Committee's General Research Panel. In addition, the General Research Panel is cooperating with the Gas Turbine Panel on the "Symposium on Effect of Cyclic Heating and Stressing on Metals at Elevated Temperatures" which will be presented this June at the ASTM Annual Meeting.

A. J. Herzig, President, Climax Molybdenum Co. of Michigan, Inc., 14410 Woodrow Wilson Ave., Detroit 3, Mich., is chairman of the General Research Panel and would welcome inquiries on any of these symposiums.

(*Continued from page 14*)

veloped by Jones & Laughlin Steel Corp., this new device has been successfully used all over the world during its first year.

The Steel City display will include other types of equipment for testing the physical properties of metals. Brinell Hardness Testers will be represented by a laboratory model and a portable instrument. A hydraulic Ductility Testing Machine (cup test) will be in operation. One of the company's Direct Reading Type Proving Rings will also be exhibited, along with miscellaneous accessories.

Streeter-Amet Co.
Booth 69

This display will feature Ametron analog to digital converters and pulse counting instruments. For display purposes there will be assembled a single piece of equipment which will measure force, pressure, temperature, length, rpm, light intensity, and electrical current. These elements are converted to digital form and may be printed as such, totalized or punched into teletype tape. Transducers will be on display for all elements so visitors may actually operate them. A production model of the Ametron pulse counter will also be shown. This instrument accepts and accumulates electrical impulses until a printing signal causes it to print the accumulation and reset to zero.

Technical Equipment Corp.
Booth 51

Differential Thermal Analysis Apparatus will be displayed by Technical Equipment Corp. The design of the multichannel unit embodies a great many features that will be interesting to a wide variety of people. The four-channel recorder contained in the unit is of a new design giving traces that are immediately visible requiring neither ink nor developing. A precision temperature control allows automatic operation up to 1000 C and is self-indexing at 100 C intervals.

Thwing-Albert Instrument Co.
Booths 5 and 6

The Handle-O-Meter and the USDA Mechanical Cotton Fiber Blender are among the instruments being displayed for the first time by the Thwing-Albert Instrument Co. These instruments have attracted widespread interest when shown at other technical meetings recently. They will be demonstrated in actual operation. In addition they will show the Electro-Hydraulic Tensile Tester and the Inkometer. The Elmendorf Tearing Tester will be exhibited in three sizes. Paper sizing equipment, such as the Currier, the Carson, and various types of transmission cups, will be displayed. An interesting item is the Clark Zero Span Attachment. The latest model Impact-Fatigue Tester will be in operation. Temperature recorders and pick-up elements will be shown as well as calibrating and checking apparatus. The range of the exhibit will cover instruments for making tensile, tearing, softness, and impact tests on plastics, textiles, paper, rubber, and many other materials.

Uddeholm Co. of America, Inc.
Booth 65

Several instruments will be in operation including the Bergsman micro hardness tester, DISA Electro Polisher, Micropol Electro Polishers, Z-323 DPH low load hardness tester, Nobel Institute calibration micrometer, and Reichert MeF metallograph.

United States Testing Co.
Booths 63 and 64

The U. S. Testing Co. instrument display will feature the newly developed NBS Stiffness Tester and the Model "C" Twist Tester. Other instruments displayed will be: the Flammability Tester, Pilling Tester, Squirrel Cage Gas Fader, and Flat Bed Press. New Certified Fugitive Tint color cards showing the complete line of Certified Fugitive Tints and listing the instructions for use, application, and scouring will be available.

Weston Electrical Instruments Corp.
Booth 41

Weston will display its line of electrical, bi-metallic, and mercury-in-glass thermometers; pressure actuated dial type thermometers; hydrometers; and recording potentiometers.

Delbert Wheeler
Booth 55

On display will be two models of the Wheeler Testing Vibrator designed for sieves from 6 to 16 in. in diameter, suitable for either laboratory or field use in grading either coarse or fine material. Special engineering features include precision-ground, double-shielded ball bearings throughout; automatic variable speed drive pulley; and aluminum alloy castings to minimize weight. Vibrators may be powered by either electric motors or gasoline engines.

Wilson Mechanical Instrument Division, American Chain & Cable Co., Inc.
Booth 40

Wilson will show its latest design MO TUKON Tester and the J Model "Rockwell" Hardness Tester. The MO TUKON Microhardness Tester will apply loads down to one gram using either the Knoop or the 136 degree Diamond Pyramid Indenter. In addition to the normal model RHT, there will be on display the RSHT, used for testing material too thin to be tested on the normal RHT, and for testing nitrided steel and thin case hardened steel.

New ASA Color Code

SAFETY for the man on the job is the purpose of the new American Standard Color Code, just revised and released to industry.

The American Standard Safety Color Code for Marking Physical Hazards and the Identification of Certain Equipment is the revision of a war standard. It uses three new colors needed to warn workers against potential dangers.

The recently born radiation perils will be announced by high-visibility purple. This color was adopted into the Code from the Atomic Energy Commission, which employs the color in a broken-propeller-shaped symbol. The code suggests that purple be used in rooms and areas, indoors and outdoors, where radioactive materials are stored or handled. Burial grounds for this material and contaminated equipment are also marked by this color. Purple signal lights may be used to indicate when radiation-producing machines are in operation.

Two other colors added to the revised code are: orange, to be used to designate dangerous parts of machines or energized equipment and to emphasize dangers from exposed or unguarded parts of machines. Blue will warn employees not to attempt to operate machines while under repair.

"If a worker is to recognize these warnings, they must mean the same, whether he goes to work in a plant in Pittsburgh or repairs a machine in Dallas," stated Vice-Admiral George F. Hussey, Jr., managing director of the American Standards Assn. "This code is not intended to conflict with any safety measures in industry; on the contrary, it was designed by industry for approval as an American Standard to make these colors uniform throughout the country."

The revised edition of the War Standard is expanded in detail. It includes technical definitions so that the colors recommended can be reproduced and lists physical samples to aid in putting the recommendations into effect.

Still a part of the code are the long-used, nationally accepted *red* for danger and fire. *Yellow* is for caution and physical hazards such as striking against, falling, tripping, etc. *Black* and *White* is for traffic—dead ends, stairways, directional signs—and housekeeping signs. *Green* is for the location of safety equipment.

The American Standard Safety Color Code for Marking Physical Hazards and the Identification of Certain Equipment, Z53.1-1953, may be obtained from the American Standards Assn., 70 E. 45th St., New York 17, N. Y., at 50 cents a copy.

Something Has Been Added

Thirty Years Progress in the Improvement of Fuels and Lubricants by the Use of Additives

By L. C. Beard, Jr.[1]

President Beard has presented this timely talk at some 15 ASTM District meetings, many sponsored jointly with local sections of other societies. The subject was made especially pertinent by recent developments as the various producing companies have enhanced their products, both fuels and lubricants, with additives. The annual report of the directors will list the various meetings at which Dr. Beard spoke.

During the past thirty years a revolution has occurred in the improvement of fuels and lubricants through the use of small percentages of various "tailor-made" chemical compounds. These compounds impart to petroleum products new and useful properties not obtainable by processes of extractive refining because these new properties are not inherent in the crude oil.

This development in fuels and lubricants improvement has resulted in the creation of a new chemical industry in which about a dozen major companies are engaged with combined gross sales of the order of 300 to 400 million dollars annually.

Table I affords a closer look at the gasoline additive business. It will be noted that tetraethyl lead far surpasses in sales volume and value all other additives. (In fact, approximately 13 per cent of all the pig lead consumed in the United States goes into the manufacture of tetraethyl lead.)

In Table I are illustrated also several additives which carry a somewhat lower sales volume, although these additives in combined dollar sales volume do have a value of several million dollars. The dosages required are rather small, but in view of the 50 billion gallons of gasoline sold annually, there is a large potential market for these products.

The application of additives to No. 2 Fuel Oil, used in home heating, is in its infancy. This business was started in the past two or three years and is rapidly expanding. The commercial offering of cetane number improvers for diesel fuels is even more recent. See Table II.

The lubricating oil additive business includes a large number of products (Table III), each one made to impart some functionally new and useful property. Detergents account for some 50 million dollars or about half of the total volume.

[1] Assistant Director, Socony-Vacuum Laboratories, Socony-Vacuum Oil Co., Inc., New York, N. Y.

Description, Applications of Additives

For the benefit of those who may be unfamiliar with the designations used for the additives described in the preceding tables, it may be helpful to explain what these addition agents do, what they are, and how some of our ASTM procedures are used in their evaluation.

Additives Classified by Effects on Properties:

As a broad generalization, additives could be divided into two classes: (1) those which affect the physical properties of the products to which they are

TABLE I.—ESTIMATED ANNUAL CONSUMPTION OF ADDITIVES FOR GASOLINE.[a]

Additive	Approximate Dosage	Million Pounds	Million Dollars
Tetraethyl lead	3 ml per gal (max)	350	225
Antioxidants	5 lb per 1000 bbl	5.5	6
Metal deactivators	1 lb per 1000 bbl	0.75	1.4
Antirust	10–50 ppm	...	Several million dollars
Anti-icing	1 per cent	...	
Pre-ignition preventers	A few tenths of 1%	...	
Upper cylinder lubricant	A few tenths of 1%	...	
Dyes and decolorizers	A few parts per million	...	

[a] Figures for tetraethyl lead are actual; others are estimated and represent in some cases only order of magnitude values.

TABLE II.—ESTIMATED POTENTIAL ANNUAL CONSUMPTION OF ADDITIVES FOR NO. 2 FUEL OIL AND DIESEL FUELS.

Kind	Dosage	Million Pounds	Million Dollars
Fuel oil (antiscreen clogging and inhibitor of sediment formation)	20–50 lb per 1000 bbl	10[a]	3–5[a]
Diesel fuel (cetane number improvers)	A few tenths of 1%	[b]	[b]

[a] Probably 50 per cent of potential.
[b] Development is too recent to attempt even an estimate.

TABLE III.—ESTIMATED ANNUAL CONSUMPTION OF ADDITIVES FOR LUBRICATING OIL.

Kind	Dosage, per cent	Million Pounds	Million Dollars
Detergents	2–10	250	50
Antioxidants—corrosion inhibitors	0.5–2	60	12
Extreme pressure agents	5–10	50	13
Viscosity index improvers	0.5–10	50	13
Pour point depressants	0.1–1	5	2
Defoamants	0.0001–0.001	...	10
Oiliness imparters	0.1–1	[a]	
Antirust agents	0.1–1	...	
Fluorescent dyes	[a]	...	

[a] No estimate available.

added, and (2) those which affect the chemical properties. (The author is sufficiently old-fashioned to believe that, even in these days of electrons, protons, neutrons, some will not take exception to this approach.)

Physical Classification.—Some agents for fuels and lubricants that perform their useful function by physical means are as follows:

1. *Oil-Soluble Dyes.*—These add color to gasoline and color or fluorescence to lubricating oils.

2. *Anti-icing Agents.*—They are mutually soluble in gasoline or water, dissolve more readily in water, lower its freezing point, and prevent ice formation in the fuel system.

3. *Upper Cylinder Lubricants.*—These are light lubricating oils added to gasoline for extra upper cylinder and valve lubrication.

4. *Viscosity Index Improvers.*—These are long-chain polymers soluble in lubricating oil which lessen the change of viscosity with temperature; they provide adequate viscosity at operating temperatures consistent with low viscosity necessary for easy starting.

5. *Pour Point Depressants.*—These are high molecular weight polymers, semiresinous; they lower the freezing point of oils by coating the wax crystals with an adsorbed film which inhibits the formation of an immobilizing matrix.

6. *Defoamants.*—Polymeric materials relatively insoluble in oils which destroy (in some manner, not yet known) the permanence of foams. Silicone oils are representative.

Viscosity index improvers, in addition to their uses described above, are being usefully employed in compounding crankcase oils spanning several SAE grades which are improved from the standpoint of deposit formation. In making such oils, selection must be made of a suitable lubricating oil distillate of low carbon residue. Bright stocks are not used in significant amounts in such oils because of their relatively high carbon residue. Viscosity index improvers are then added to give viscosity to the blend as well as favorable viscosity-temperature characteristics. Of course such oils also contain detergents and antioxidants. Skill is required in refining a proper base oil and in selecting the right additives and the proper proportions in which to use them.

Chemical Classification.—Additive compounds which function by chemical effect on fuels are described below:

1. *Antiknock Agents for Gasoline.*—These prevent sudden inflammation of portions of highly compressed fuel-air mixtures with subsequent impact of molecules with high kinetic energy against the pistons and cylinder walls. Tetraethyl lead is the most important.

2. *Cetane Number Improvers for Diesel Fuels.*—These promote prompt inflammation of injected fuel, thereby providing smoother operation. These compounds are somewhat opposite, in effect, to tetraethyl lead. Organic nitrates, nitro compounds, and peroxides are typical.

3. *Antioxidants.*—By the act of breaking chain reactions, these prevent condensation of certain readily oxidizable hydrocarbons to gummy substances which might deposit in the fuel system and on valves. Amino phenols, alkyl substituted phenols, and substituted phenylenediamines are representatives.

4. *Antirust Additives for Gasoline.*—They are surface-active materials which coat ferrous metals with a hydrophobic film and prevent water-metal contact. Ammonium sulfonates and organic acid-phosphorus compounds are examples.

5. *Metal Deactivators.*—These form nonionic coordination complexes with metal impurities, especially copper, and make them noncatalytic as concerns promoting oxidation to gum. N-N'-disalicylidene-1:2-diaminopropane is the outstanding deactivator. (As little as a few parts of copper in ten million parts per million of gasoline can be catalytic.)

6. *Pre-ignition Preventers for Gasoline.*—These minimize glow of cylinder deposits, the incandescence of which might otherwise cause pre-ignition. As an additional effect they are said to combine with lead from tetraethyl lead to prevent shorting of spark plugs. Organic phosphates and phosphites are typical.

7. *Antiscreen Clogging Agents for Home Heating Oil.*—These are surface-active oil-soluble materials which keep sediment in suspension and prevent water from binding the sediment together to form an impassible mat on the burner screens. Alkali and alkali earth sulfonates and certain nonash-containing materials are typical.

8. *Decolorizers for Kerosine.*—These destroy color-forming bodies that result from oxidation during storage. Hydroquinone and substituted hydroquinones are representative.

Returning to the topic of prevention of pre-ignition: with the higher compression ratios of today's engines, pressures and temperatures are higher. Deposits of lead compounds bound together by carbonaceous material accumulate on pistons and in combustion chambers. These deposits tend to raise the compression ratio even higher and also exert a thermal insulating effect so that higher temperatures obtain on the walls of the combustion chamber and the piston. It has been estimated that about one third of the effect is due to increase in compression and the balance is due to the insulating effect. These higher temperatures promote glowing of the deposits such that they may act as sources of ignition prior to passage of the spark. Pre-ignition preventers are said to suppress glow. Another way to combat pre-ignition is to provide higher and higher octane number gasoline, since the hydrocarbon composition of such gasoline is less susceptible to ignition by glowing particles. A third way is to minimize cylinder and piston deposits by use of a suitable lubricating oil of low deposit forming nature, such as was described above.

There has been omitted from the list of additives for fuels, lime or other alkaline earth oxides or soaps added to residual fuel oils to combine with the vanadium pentoxide present in oil ash. It may be surprising to learn that as much as 80 per cent of oil ash can be vanadium pentoxide. (This is a fascinating observation because this unusual and scarce metal is probably in oil ash as the fossil remains of porphyrins that were present in the organisms from which petroleum was formed—just as our blood contains iron in the hemoglobin and plants contain magnesium in their chlorophyll.)

Vanadium pentoxide when molten at temperatures above 1275 F is a very corrosive material and can seriously attack metals—such as the blades of gas turbines. Lime forms, with vanadium pentoxide, calcium vanadate which has a much higher melting point, and hence the vanadium pentoxide is rendered less corrosive. (A very interesting paper on this subject by C. T. Evans, Jr., of Elliott Co. received the ASTM Sam Tour Award in 1951.)[2]

Lubricating Oil Additives:

Chemical Classification.—Some lubricating additives classed by their chemical effects are as follows:

1. *Detergents.*—These keep engines clean, reduce wear, neutralize acids formed in the oil, and prevent oxidative condensation. They peptize resinous oxidation products, keeping them suspended in the oil. Generally they are complex barium or calcium sulfonates or phenates containing more than the stoichiometric amount of metal.

2. *Antioxidants—Corrosion Inhibitors.*—They prevent formation of corrosive acids in engine oil with the subsequent attack on hard alloy bearings; they act as antioxidants and form cor-

[2] C. T. Evans, Jr., "Oil Ash Corrosion of Materials at Elevated Temperatures," Symposium on Corrosion of Materials at Elevated Temperatures, p. 3, Am. Soc. Testing Mats. (1950) (Symposium issued as separate publication.)

TABLE IV.—ASTM METHODS FOR EVALUATING PROPERTIES OF ADDITION AGENTS.

Property Evaluated	ASTM Designation "D"
Knock characteristics of motor fuels	357, 908, 614, 909
Gum and oxidation stability of gasolines	381, 525, 873
Color	155, 156
Oxidation	971, 974, 664, 94, 939, 943, 670
Antirust	665
Pour point	97
Foaming	892
Viscosity	445, 88, 446, 666, 567, 341
Amount of additive present	526, 808, 1091, 874, 1026, 810, 1216, 855, 811

rosion-resistant coatings on metals. Generally they are complex organic compounds of sulfur and phosphorus or mixtures of such compounds. In turbines and other industrial oils, a different class of antioxidants is used—usually substituted phenols and aromatic amines—to prevent formation of acids, sludges, and emulsions under conditions of relatively low temperature operation.

3. *Extreme Pressure Agents.*—These are used where gear tooth pressures may at times go far above 100,000 psi (as in hypoid gears); they prevent metal-to-metal contact and subsequent welding. They are organic compounds of sulfur, chlorine, and phosphorus, which react with the gear teeth to form sulfide, chloride, and phosphide coatings. Some of these coatings have a leaf-like structure and in this respect function like graphite. Lead soaps may also be used, alone or in combination.

4. *"Oiliness" Agents.*—These decrease friction. Generally they are fatty acids, phosphorus or chlorine compounds. These agents may act by forming unctuous metal soaps or eutectics that fill in the "valleys" or melt down the "hills" in the microscopic unevenness of bearing surfaces.

The published research on this subject would fill volumes and industry is spending millions of dollars trying to get answers as to the "whys" of some of these phenomena.

Evaluation of Additives

It is appropriate at this point to outline and classify some of the methods used in evaluating the useful properties of addition agents. Many of these methods are ASTM methods. Table IV illustrates some of the ASTM methods used for evaluating additives.

Note that there are some thirty standard or tentative ASTM methods associated with the additive industry, and there are many more ASTM methods that are considered as auxiliary.

Economic Significance of Additives

What is the economic significance of additives? For one thing, tetraethyl lead in combination with improved refinery processes has given us motor gasoline with an octane number in the 90's and aviation gasoline with over 100. Over the past thirty years this has permitted increases in compression ratios from 4:1 to 8:1 with attendant increases in power, economy, and acceleration. The gasoline bought today is 50 per cent better than in 1925; two gallons now do the work that three did in 1925 and at no increased cost—only the taxes are higher. All of this has been possible with a 52 per cent increase in general living expenses.

Figure 1 shows an acceleration test conducted at Idlewild Airport—20 sec after the start of the test the 1953 car (in front) fueled with 1953 gasoline pulls far ahead of the same model car using 1925 gasoline. The car in the rear is of the 1920's and is fueled with 1925 gasoline.

The quality of our aviation gasoline was an important factor in winning World War II. Today's airplanes would not take off with the aviation gasoline of twenty years ago.

Antirust additives save millions of dollars worth of steel annually in preventing the rusting of product pipelines and tankers. They reduce contamination of gasoline with rust particles which get into carburetors and fuel lines.

Figure 2 shows test specimens taken from a pipeline when an antirust additive was used and when it was not. The specimen where the additive was used is bright and shiny. The other is badly rusted.

NOTE.—The following section of President Beard's talk dealing with corrosion problems was presented at Dallas because this meeting was held jointly with the Fort Worth-Dallas Section of the National Association of Corrosion Engineers.

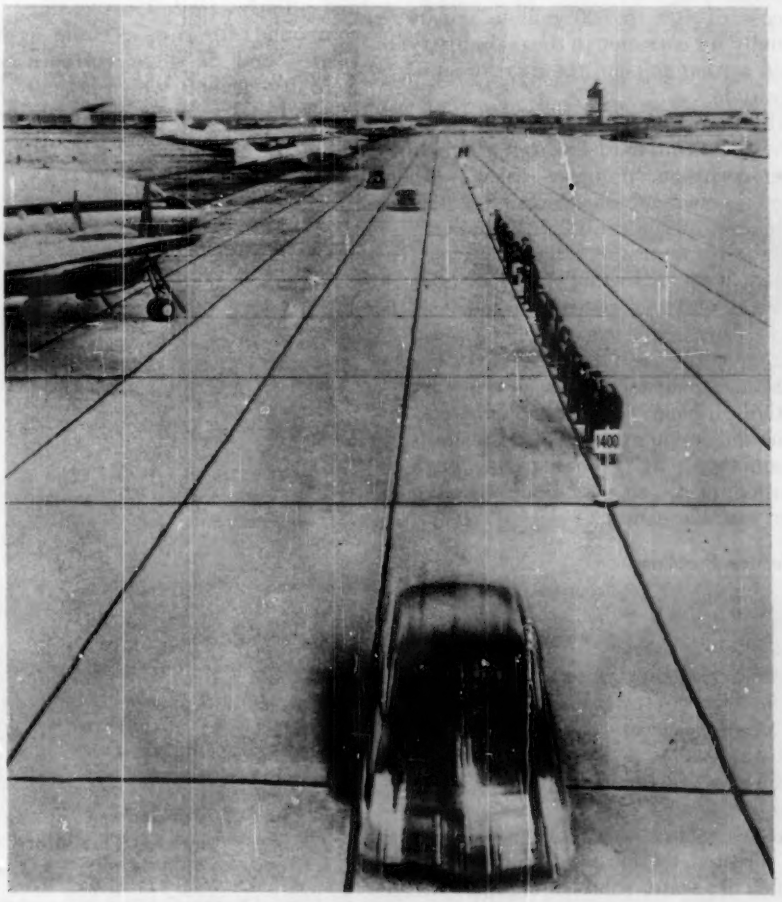
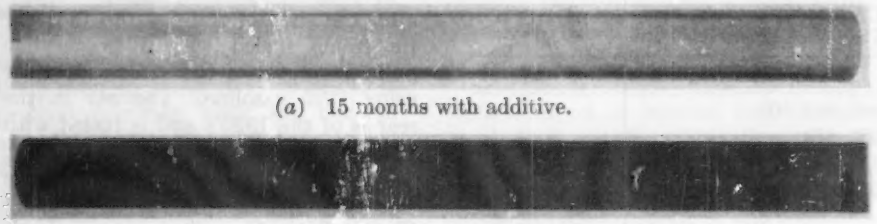


Fig. 1.—Acceleration Tests Comparing 1925 and 1953 Gasolines.



(*a*) 15 months with additive.

(*b*) 2 months without additive.

Fig. 2.—Additives for Prevention of Internal Pipeline Corrosion.

Oil Industry's Corrosion Problem

It might be well, at this point, to discuss generally the subject of corrosion problems in the oil industry which is somewhat related to the topic of additives.

First, how costly is corrosion to the oil industry? John W. Newton, Vice President of the API Division of Refining and of the Magnolia Petroleum Co. has said that, based on an API study, corrosion may be costing the refineries as much as a quarter of a billion dollars annually. An independent estimate by *Petroleum Processing* is that corrosion costs 9 cents per barrel of crude oil processed—which is roughly equivalent to Mr. Newton's estimate. Corrosion of production and transportation equipment will increase this figure.

The author estimates that an overall cost of 400 to 500 million dollars annually for corrosion in the oil industry would appear to be of the right order of magnitude.

Why is corrosion so severe and costly to the petroleum industry, and where do these corrosion problems occur? In every segment of the industry, from production of the crude oil to delivery to the customer, the industry is confronted with corrosion problems. It has most of the corrosion problems of every other industry and frequently in a more severe form. Practically all storage is in steel tanks, so there are all the problems of atmospheric corrosion and frequently the atmosphere is contaminated by saline mists. Such corrosion, of course, is combated by the use of suitable paints.

Production Problems

In production, oil-well casings, drill stems, and sucker rods come in contact with saline waters, hydrogen sulfide, organic acids, and crude oil. In some instances, recourse is had to suitable alloys; formaldehyde is said to lessen oil-well corrosion due to hydrogen sulfide; organic acids can be combated by keeping the pH sufficiently high. More recently, attention has been directed to the use of certain oil-soluble or water-soluble organic inhibitors. In general, these are polar molecules, one end of which may be an amine, an acid ester of phosphorus, or a carboxy acid. The other end of the molecule is hydrocarbon. The active end of the molecule unites with the metal and presents the hydrophobic hydrocarbon end to the corrosive aqueous solution. In substance, such compounds plate metal with a water-resistant film and prevent harmful corrosive contact. The films are continuously renewed by adsorption of the compounds from the oil.

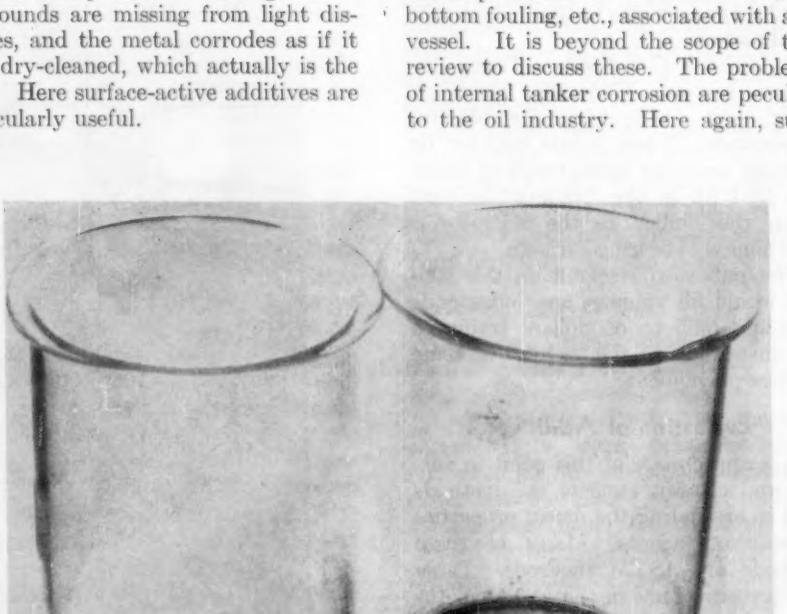
Acidizing to increase permeability presents problems. It is, of course, necessary to use inhibited acid for this purpose. Distillate wells and equipment handling such distillates present a particularly severe problem. Crude oil naturally contains high molecular weight hydrocarbons and surface-active materials that can be adsorbed on metal and afford a protective coating. Such compounds are missing from light distillates, and the metal corrodes as if it were dry-cleaned, which actually is the case. Here surface-active additives are particularly useful.

Storage and Distribution

After oil has been brought to the surface, it must be stored in field tanks and then moved to the refineries by pipeline or tanker. Underside roof corrosion of tanks holding sour oil containing hydrogen sulfide is a problem. Metal spraying with aluminum can be protective. Also, use is made of ammonia and of suitable sulfur-resistant paints.

Pipelines present problems of both external and internal corrosion. External corrosion is combated by wrapping the pipes with a coating of asphalt, bitumen, or plastic tape, cathodic protection by imposing a negative current, or by the use of sacrificial anodes—such as magnesium. Internal corrosion can be lessened by dehydrating the products by passage through a bed of activated alumina. Water-soluble inhibitors, such as sodium chromate or nitrite, are also used. Such protection, through the use of aqueous solutions, however, means water in the pipeline, and particularly for the case of product lines, frequent scraping is entailed. More recently, quite favorable results have been obtained with oil-soluble organic inhibitors such as were mentioned earlier. An additional advantage of these is that the protection travels right along with the product to the consumer.

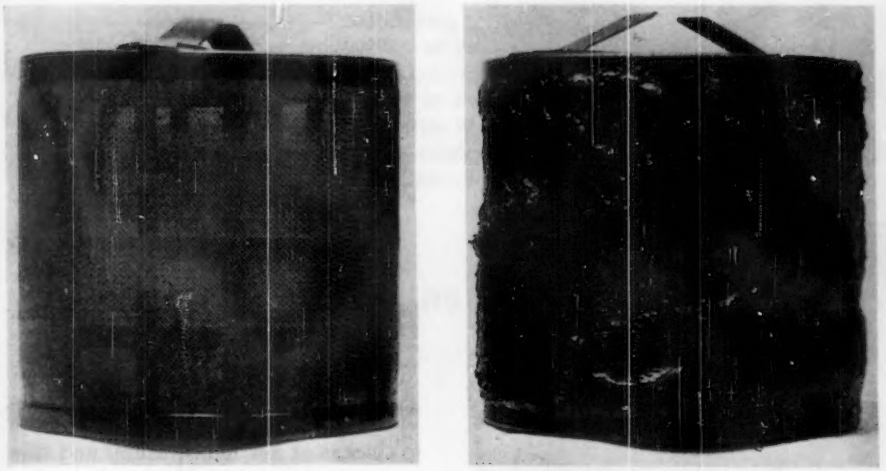
In the case of tankers, there are the usual problems of marine corrosion, bottom fouling, etc., associated with any vessel. It is beyond the scope of this review to discuss these. The problems of internal tanker corrosion are peculiar to the oil industry. Here again, such



(*a*) With inhibitor. (*b*) Without inhibitor.

Fig. 3.—Gum from Gasoline.

NOTE.—Contrast in this photograph is much more pronounced in the color slides used in Dr. Beard's talk.



(*a*) With additive. (*b*) Without additive.

Fig. 4.—Domestic Oil Burner Screens.

problems are particularly severe with vessels handling light distillates which contain no natural protective film-forming material. It has been estimated that the shell of a crude oil tanker lasts about three times as long as one hauling gasoline. A recent 18-month test on several gasoline tankers has shown that a high molecular weight organic acid type inhibitor in a proportion of 40 ppm, cut corrosion in half. Another problem which has caused increasing attention is pitting corrosion. Apparently, this is caused by crude oil sediment holding drops of corrosive water (from Butterworthing—a pressure spray rinse with seawater—or ballasting, or from water of production) in intimate and corrosive contact with metal surfaces. It is believed this problem can be solved by spraying the tanks with fresh water made alkaline.

Refinery Corrosion

In refinery corrosion, there exists probably every known corrosion problem. There is low-temperature corrosion as well as high-temperature corrosion. There are acid waters, saline waters, sulfuric acid, hydrofluoric acid—to name only a few.

One of the first things a refiner must do is to separate the salts from the crude oil. This is done by washing with water and settling—most frequently aided by electric precipitation. Magnesium chloride is extremely undesirable since it decomposes to give hydrochloric acid. Ammonia can be used to counteract this. Ammonia is also injected to offset the effects of hydrogen sulfide; lime and caustic soda are also employed. Naphthenic acids present a problem. Severe corrosion from this cause may occur at the point where condensation of distillates bearing such acids occurs. Caustic soda used in the stills helps combat this.

The increasing sulfur content of crude oil has added to the refiners' problem and costs through the necessity for greater use of alloy steels.

Corrosion in refineries is a serious matter and involves more than simply the attrition of equipment. Since much of the equipment operates at high pressures and temperatures, severe corrosion may give rise to rupture, costly shutdowns, and even loss of life. Frequent and methodical inspection is a must in combating refinery corrosion. As each new case is discovered, it must be subjected to careful examination and analysis; corrective measures must be taken promptly.

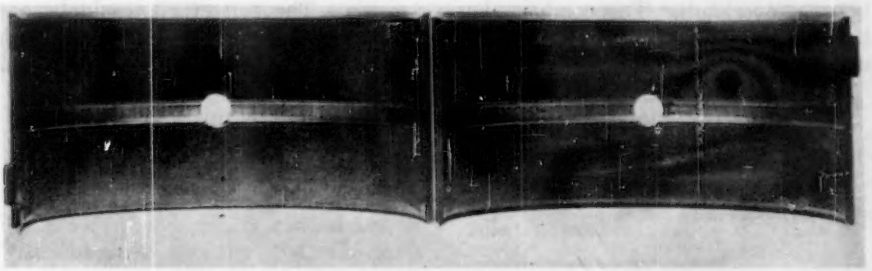
Just to emphasize the variety of refinery corrosion occurrences, there came to the author's attention a freak failure ascribed to mercury, of an aluminum heat exchanger. (Mercury forms an amalgam with aluminum which floats away the usually protective coating of aluminum oxide and then the metal air oxidizes at an accelerated and unimpeded rate.) Since analysis of the crude oil revealed no mercury, it can only be assumed that contamination from some instrument containing mercury was the cause.

Other Uses of Inhibitors:

Antioxidants (gum inhibitors) prevent deterioration of gasoline during storage and the formation of gummy materials which deposit in the intake manifold, on the carburetor, in the butterfly valve, and on the valve stems. Figure 3 shows the deposit left on the evaporation of 100 ml of gasoline after storage with and without gum inhibitor.

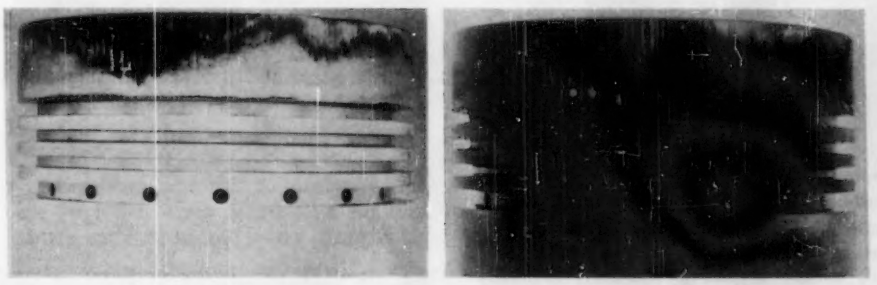
Perhaps one of the newest uses for additives has been in home heating oil. Many home owners probably have experienced shutdown of their oil burners at home—usually on the coldest day or at the most inconvenient time—due to a clogged filter screen. Figure 4 shows how effective these antiscreen clogging additives can be in preventing this trouble.

With the advent some years ago of hard alloy bearings, corrosion and ulti-



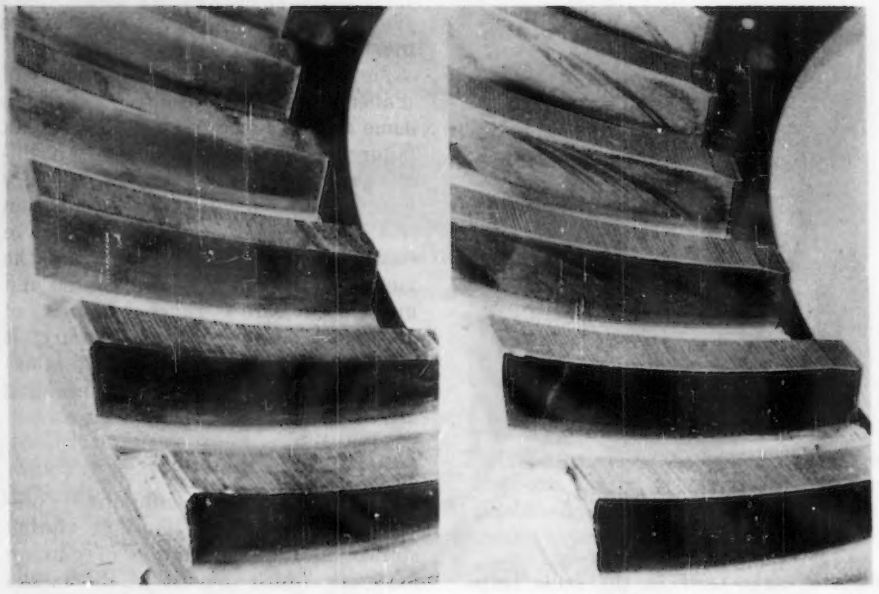
(*a*) With inhibitor. (*b*) Without inhibitor.

Fig. 5.—Crankshaft Bearings After 36-hr Test.



(*a*) With detergent. (*b*) Without detergent.

Fig. 6.—Lacquer Deposits on Caterpillar Diesel Pistons After 480 hr.



(*a*) With extreme pressure additive. (*b*) Without additive.

Fig. 7.—Hypoid Gears.

mate destruction of these bearings became quite a problem. This was corrected by the use of inhibitors. Figure 5 shows two crankshaft bearings after a severe 36-hr test under comparable conditions in an engine. One oil contained a bearing corrosion inhibitor, the other did not. The difference is obvious.

As severity of operating conditions of both diesel and automobile engines has increased over the years, lacquer deposits on pistons, sludge deposits in lubricating systems, and filling of ring grooves with carbonaceous materials have considerably shortened the period between overhauls. This condition has been tremendously improved by the use of detergents. They might more properly be called "engine keeper cleaners"; their action is only in part analogous to conventional household detergents. Pistons from a diesel engine operated for 480 hr on oils with and without detergents are shown in Fig. 6.

When operated on conventional gear oils, hypoid and other types of heavily loaded gears caused a host of troubles. Figure 7 shows gears operated in oils with and without extreme pressure additives. Scoring and incipient welding were the results in the gear operated in the oil without additive.

Viscosity is the most important property of a lubricant in the hydrodynamic region. The perfect oil would be one that did not change its viscosity with temperature. But lubricants do tend

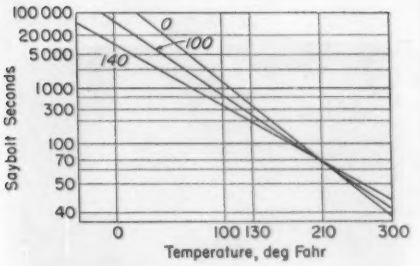


Fig. 8.—Viscosity Comparison of Motor Oils.

to thicken at low temperatures and thin out at high—making for hard starting in cold weather and inadequate protection and high consumption under severe driving conditions when motors are hot.

Viscosity Index improvers help to flatten the viscosity-temperature curve as shown in Fig. 8. The line designated as zero viscosity index is an oil containing no viscosity index improver. The 100 and 140 lines contain increasing amounts respectively. The decreased slopes of these two lines are significant.

ASTM has played an important part in providing test methods for evaluating many of these developments. The petroleum, automotive and chemical industries have contributed their share without materially increasing product cost to consumers. Because of all these additives, sometimes those in the industry wonder when the refineries will become chemical plants—or, as one observer rather aptly put it—"Sir, is there petroleum in your products any more?" There is—about a trillion pounds annually.

Symposium on Engine Lubrication

The following three papers by Mougey, Junge, and Hamer, Tutwiler, and Weisel were presented as a Symposium on Passenger Car Engine Designs and Operating Conditions and How They Affect Lubricating Oil Requirements, sponsored by Technical Committee B on Lubricating Oils, at a meeting of Committee D-2 on Petroleum Products held during the 1953 Annual Meeting of the Society.

The purpose of this Symposium is to provide information on service requirements of engines under various operating conditions with a view toward defining some of the criteria that should be applicable to the new American Petroleum Institute Service Classifications for motor oils.

Engine Wear as Affected by Lubricant Composition

By H. C. Mougey

As is well known there are four important factors in engine wear which must be considered. These factors affecting engine performance are (1) engine design, (2) operating conditions, (3) fuels, and (4) lubricants. In this discussion on engine wear these four factors must constantly be kept in mind.

Types of Wear:

At the present time wear or poor operation of the parts in the valve system and high oil consumption, which the car owners believe to be the result of high wear of rings and cylinder walls, appear to be the two main reasons why engines are overhauled. Perriguey,[1] and Kunc, McArthur, and Moody[2] believe that wear, with or without the added effect of deposits, is the reason why 85 per cent of the engines are overhauled and that only 15 per cent are overhauled for deposits alone plus all other reasons. Table I is reproduced from papers by these authors.

If the length of time before the need for overhaul could be increased, it might have a great effect on cost of operation of cars and it might also have an important effect on resale value of the cars.

TABLE I.—REASONS FOR ENGINE OVERHAUL.

Reason for Overhaul	Percentage of Engines Examined
Wear alone	57
Wear and deposits	20
Wear and mechanical failure	8
Total badly worn	85
Deposits alone	5
All other reasons	10
Total examined	100

NOTE—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] W. G. Perriguey, "Motor Oils—Life Expectancy," *Proceedings*, 32nd Annual Meeting, Am. Petroleum Inst., Section II, Marketing, Chicago, Ill., Nov. 10–13, 1952.

[2] J. F. Kunc, Jr., D. S. McArthur, and L. E. Moody, "How Engines Wear," SAE Summer Meeting, Atlantic City, June 1–6, 1952.

The importance of engine wear as distinct from deposits has only recently received the attention it appears to deserve.

Kunc, McArthur, and Moody[2] divide wear into three types, friction wear, abrasive wear, and corrosive wear. They believe that "most engines are worn by friction and mild abrasion" rather than by "corrosive wear." They distinguish between these three types of wear by the appearance of the metal surfaces at a magnification of 440 diam. They state:

"It was found that a friction worn surface is relatively smooth, an abraded surface is heavily ridged, and a low temperature corroded surface is completely covered with pock marks and craters."

However, Ryan and DeLong[3] have a different definition for corrosive wear. They state:

"Corrosive wear is defined as all wear of piston rings and cylinder walls which is initiated by chemical attack. Corrosion would be of little consequence in the absence of rubbing, as indicated by the fact that there is practically no loss of cylinder metal in the area above ring travel. Considerable time of operation at high temperature may be required before the abrasives caused by corrosion are finally carried out of the ring-belt area by the oil. Any such carry-over effect is considered wear due to corrosion. This concept of corrosive wear thus differs from that of some investigators who place in the category of abrasive wear all metal removed by a mechanical action, regardless of whether the metal attack was initiated by corrosion or by foreign contaminants."

Corrosive Wear:

Operating conditions, under which are included such factors as maintenance, car speeds, and loads, etc., greatly affect the kind and amount of wear which may occur. Many papers have been given to point out the effect of corrosion due to water and acid products resulting from the burning of the gasoline, and to show that this trouble is much less when the jacket temperatures are high enough to prevent or decrease the formation of these products of condensation. As early as 1924 Clayden[4] showed that water is condensed in the combustion chambers during engine warm-up and that this water gets past the pistons and gets down into the crankcase oil.

Figure 1 is from a paper[5] by J. C. Geniesse and H. R. Jackson, and shows how ring wear varies with cylinder wall temperature and how it is possible to decrease this wear by using "high additive oil," even when the engine is operated with unfavorable low cylinder wall temperatures.

Actual road tests reported by Palmer[6] indicate that the use of "additive oils" greatly decreases ring wear. Figure 2 is from the paper by Palmer.

[3] J. G. Ryan and B. W. DeLong, "The Mechanism of Corrosive Wear in Passenger-Car Service," Mid-Year Meeting of the Am. Petroleum Inst., Division of Refining, New York, May 14, 1953.

[4] A. L. Clayden, "Water in Crankcase Oils," *SAE Journal*, Vol. 15, No. 1, pp. 47–50 (1924).

[5] J. C. Geniesse and H. R. Jackson, "Role of Corrosion in Engine Wear," *Petroleum Processing*, Vol. 7, Nov., 1952, pp. 1620–1622.

[6] J. L. Palmer, "Effect of Heavy Duty Oils on Engine Wear in Typical Passenger Car Service," paper presented at the SAE Summer Meeting, June 1–6, 1952.

H. C. MOUGEY from 1939 to his retirement in 1953 was Technical Director, Research Laboratories Division, General Motors Corp. where he worked on many automotive problems, including car finishes, plating, and lubrication. He is the author of numerous papers on these subjects.

Similar conclusions were reached by Kavanagh.[7] Figure 3 is from the paper by Kavanagh.

Engine Wear as Measured by Oil Consumption:

In Fig. 3 the effect of lubricating oil on engine life by measuring the engine wear in terms of oil consumption in miles per quart rather than by showing the change in dimensions of the piston rings and cylinder walls is shown. This measure of miles per quart may not be a strictly accurate measure of wear, from a scientific standpoint, but it certainly is a practical measure of engine wear. When the engine gets into a condition where it uses oil at a high rate, the average car owner says it is worn out and needs to be overhauled.

However, this measure of miles per quart, as affected by wear of the cylinders and piston rings, is not only a measure of engine wear, and thus comes within the scope of this paper on engine wear, but it is also a measure of the ability of an oil to prevent wear, a property of the oil that affects oil consumption just as much as the oil properties of viscosity, volatility, or viscosity index affect oil consumption. In the *SAE Journal* of March, 1941, there is a paper by Mulit and Kavanagh[8] on "Lubricating Oils for Internal Combustion Engines." In this paper Mulit and Kavanagh show a typical curve of oil consumption as affected by wear of the engine. Figure 4 is reproduced from this paper. It will be noted that with straight mineral oil, which was the oil generally used in passenger cars in 1940 when Mulit and Kavanaugh developed this curve, the miles per quart increase while the rings are being worn in, but as the cylinder walls and piston rings wear, the miles per quart rapidly decrease, so that at 25,000 or 30,000 miles the engine is worn out. However, at the present time passenger cars, as well as trucks, etc., are lubricated with heavy duty oils which are much superior to straight mineral oils in reducing engine wear. Consequently, the shape of the curve of miles per quart *versus* total miles of service of the engine does not drop at a rapid rate, as shown in this curve for mineral oil, but the miles per quart at the end of 25,000 miles of engine service may be as great or greater than it was at 5000 miles.

Figure 5 illustrates this property of the oils to prevent engine wear. Three cars, of the same make and model, were put on test at our General Motors Proving Ground, using three heavy duty oils, two 20W oils, and a 5W-20 oil. All of these three oils had approximately the same viscosity at 210 F and they all gave oil consumption values of 2000 miles per quart or over during the first 1500 miles of controlled break-in, which, of course, is run at a lower average speed than the actual durability test which is made following the break-in. As soon as the cars were put on the regular high-speed durability run it was found that all three oils gave miles per quart of between 1000 and 1500. They remained within this range during the entire test, and when the test was finished at 25,000 miles one 20W oil was giving 986 miles per quart. The other 20W oil was giving 1412 miles per quart, and the 5W-20 oil was giving 1051 miles per quart.

This is the same story that was told by C. M. Larson[9] in his paper, "Engine Deposits and Wear." Figure 6 is from Mr. Larson's paper. The two curves represent tests on different fleets, and so they are not comparable in actual miles per quart, but they are comparable in respect to the shapes of the curves. With straight mineral oil, which does not have sufficient ability to prevent wear of cylinders and rings, the

[7] F. W. Kavanagh, "Engine Wear—Comparison of Radioactive Wear and Field Measurements," paper presented at the SAE Summer Meeting, June 1–6, 1952,.

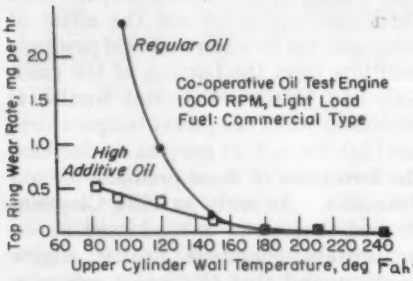


Fig. 1.—Regular *versus* High Additive Oil with Varying Cylinder Wall Temperatures.

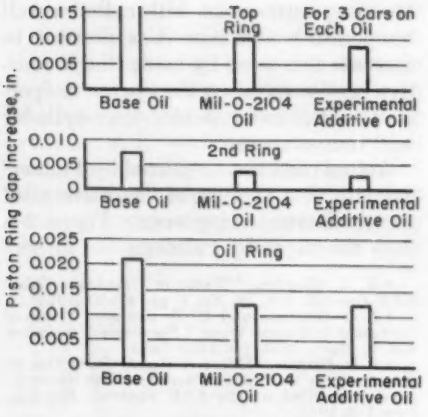


Fig. 2.—Average Piston Ring Wear as Affected by Oil Type.

Engine 1950 236-cu in. Powerglide—miles approx. 14,000—service: "home to work."

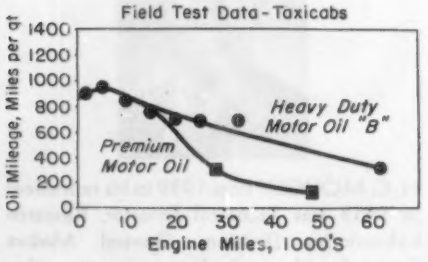


Fig. 3.—Effect of Lubricating Oil on Engine Life as Shown by Rate of Change of Oil Mileage.

Field test data—taxicabs.

[8] L. L. Mulit and F. W. Kavanagh, "Lubricating Oils for Internal Combustion Engines," *SAE Journal (Transactions)*, Vol. 48, No. 3, March, 1941, pp. 98–106.

[9] C. M. Larson, "Engine Deposits and Wear," paper presented at 18th Mid-Year Meeting of the American Petroleum Institute's Division of Refining, New York, N. Y., May 14, 1953.

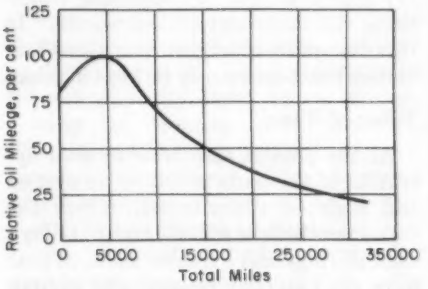


Fig. 4.—Relationship Between Engine Age and Oil Mileage.

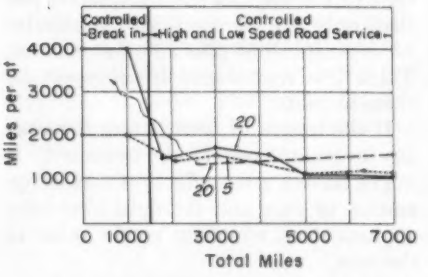


Fig. 5.—Controlled Break-in and High and Low Speed Road Service.

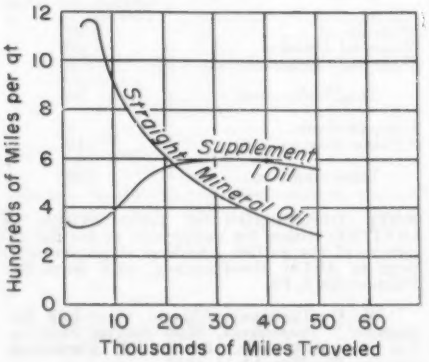


Fig. 6.—Oil Consumption of New York City Taxicab Fleet.

miles per quart rapidly decrease as the engines wear, so that at 50,000 miles the engines with straight mineral oil are worn out and in need of overhaul. However, with the high additive heavy duty oil, the rate of wear of the cylinders and rings is so low that at 50,000 miles the engines are still giving about as many miles per quart as they ever did, and the time when the engines need to be overhauled is very greatly postponed.

Importance of Problem of Corrosive Wear:

When engineers wish to test cars under severe operating conditions, they usually drive them at high speeds so that high mileages may be accumulated in a short time. However, it appears that slow speed, intermittent operation, stop-and-go service is also a very severe type of service, and that the percentage of cars subject to this severe type of service is much larger than most people believe. If tests are limited to the high speed, high mileage types, this very important stop-and-go field of corrosive wear is largely overlooked.

In October, 1951, the Defense Transport Administration published a booklet,[10] "Automobile Transportation in Defense or War." Tables II and III are from this publication. It is probable that the data shown for 1950 are also typical of operations today. I believe most people will be surprised to note that, in the data shown, one third of the cars traveled less than 5000 miles per year, and that almost half of the cars (47.7 per cent) traveled less than 7000 miles per year (583 miles per month).

TABLE II.—MILEAGE TRAVELED IN 1950.[a]

Annual Mileage per Car	Cars, per cent
3 000 or less	19.9
3 001 to 5 000	14.1
5 001 to 7 000	13.7
7 001 to 9 000	9.6
9 001 to 11 000	12.2
11 001 to 15 000	13.9
15 001 and over	16.6
Median miles per car	7500
Average miles per car	9340

[a] Alfred Politz Research, Inc.

TABLE III.—LENGTH OF AUTOMOBILE TRIPS.[a]

Length of One-Way Trip	Percentage of All Trips
Less than 3 miles	38.4
3–6	24.2
7–13	18.2
14–23	11.1
24 or more	6.9
Not known	1.1
All trips	100.0

[a] Alfred Politz Research, Inc.

Ryan and DeLong[4] studied the effect of the type of service on ring wear.

[10] W. Owen, "Automobile Transportation in Defense or War." Brookings Inst., Washington, D. C. (1951).

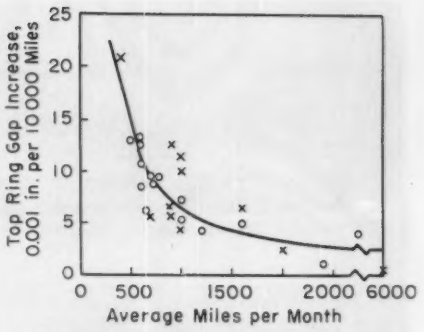


Fig. 7.—Effect of Type of Service on Ring Wear.

Figure 7 is from their paper. From Table II and Fig. 7 it would appear that about half of the passenger cars are operating under conditions where corrosive wear may be serious unless the car owners use oils that are very rust resistant.

Importance of Corrosion-Resistant Oils:

It has been shown that wear due to low cylinder wall temperatures can be greatly decreased by either of the two methods: (1) use of oils resistant to rusting and corrosion and (2) engine designs which maintain high enough jacket temperatures to prevent condensation of water and acids from the products of combustion of the fuel.

Consequently, many people believe that if the automobile engineers would only pay a little more attention to devices to keep cylinder walls warm, there would not be any need for oils that are resistant to rusting and corrosion. However, they fail to recognize that even though the engines may be equipped with thermostats and crankcase ventilators, if the engines are operated for only short periods per day, there may not be sufficient time for the engines to reach the higher temperatures required to decrease the formation of water and other condensation products or to eliminate these materials from the crankcase oil after they are formed. Trucks in over-the-road service frequently operate 100,000 miles or more between overhauls, but many passenger car engines, even though equipped with filters, air cleaners, thermostats, and crankcase ventilators require new rings after 30,000 to 45,000 miles. In other words, it appears that regardless of what the automobile manufacturer may be able to do in respect to control of jacket temperatures, oils that are known to have rust-protective properties should be used.

The Problem of Testing for Corrosion Resistance:

We still have the problems of determining how resistant to corrosion the oils should be, how to test the oils to determine their resistance to corrosion, and under what operating conditions the oils of different degrees of rust resistance may be most desirable.

In the January, 1952, issue of *Lubrication*, a publication of The Texas Oil Co., an excellent paper, entitled "Modern Automotive Engine Oils," was published. In this paper the following paragraph is found:

"Normally the degree of protection against rusting of cylinder walls, wrist pins, and crankshaft bearing surfaces provided by a straight mineral oil is quite adequate for internal combustion engine operation. However, rusting in these areas may become serious in new engines during transit or in storage and to a lesser extent in used engines during long-time storage under humid conditions. Such rusting is caused by droplets of water penetrating the oil layer and attacking the ferrous parts. Special additive type preservative oils are used under severe rusting conditions. However, the heavy duty type oils in general markedly enhance the rust protection afforded by a straight mineral oil.

In order to throw some light upon these problems, we have developed a special, very severe test schedule in which we operate a Chevrolet Powerglide engine for 21 hr in 3-hr periods, with intervals between each of these operating periods during which the engine is shut down. To increase the severity of the test, the ventilation is entirely blocked off and the temperatures are maintained at very low levels. This test schedule is shown in the Appendix.

Figure 8 shows the piston pins from two of these 21-hr tests. The Heavy Duty MIL-0-2104 oil used in the test with the piston pin shown at the top permitted considerable rusting. However, in the test with the pin shown at the bottom a supplement 2 oil was used. Rusting was entirely prevented.

Figure 9 shows three intake valve stems from three tests on the same very severe schedule. The two intake valve stems at the top are from two tests using two different heavy duty oils, while the valve stem at the bottom is from a test using supplement 2 oil. The heavy duty oils at the top permitted bad rusting but the supplement 2 oil prevented rusting.

Figure 10 shows pistons from the hydraulic valve lifters from two tests, the one at the left using heavy duty oil and the one at the right using supplement 2 oil. The superior rust-resistance properties of the supplement 2 oil are again apparent.

Unfortunately, at the present time, the average car owner does not know

which heavy duty oils are superior in rust resistance, and the only real answer to this problem of rust resistance under the most severe stop-and-go operating conditions appears to be supplement 2 oil. However, this test schedule which we use is very severe, and field experience may show that supplement 1 oils are sufficiently resistant to corrosion to be satisfactory from a commercial standpoint in all cases except those under the most severe operating conditions, which could be handled as special cases. For operations where the jacket temperatures are high most of the time, oils of the MIL-0-2104 level may possibly be found by experience to be sufficient. Also, in the development work now being done on this subject by the oil industry, they may be able to improve the rust resistance of conventional MIL-0-2104 oils by the use of improved additives or by a combination of the present anionic detergents with nonionic detergents so that the more expensive supplement 1 or supplement 2 oils may not be required.

At first, when we developed this corrosion test and examined a number of heavy duty oils and found some of them to be much inferior in rust resistance to others, we thought that we had a test which could be used by the oil and automotive industry to evaluate the rust-resistant properties of oils. Later work indicated that the properties of the gasoline used in the test may greatly affect the results, and a heavy duty oil, when tested in one laboratory with one gasoline, may appear to be much better than the same heavy duty oil tested with another gasoline in the same or another laboratory. However, it still appears that the test is reliable when the same gasoline is used in comparing both oils, although when some gasolines are used the test is less severe and a longer operating time is required to show the differences between the oils.

Importance of High Film Strength or Extreme Pressure Properties:

As previously pointed out, in addition to the wear associated with stop-and-go service, we also have the problem of wear under conditions where the effect of high film strength or extreme pressure crankcase oils may possibly be important.

In the January, 1952, issue of *Lubrication* this subject is discussed, as follows:

". . .Another facet of crankcase lubrication involving the oil layer at metal surface of moving parts concerns load carrying capacity which as measured by laboratory testing machines is commonly termed 'film strength.' A straight mineral oil normally provides fluid

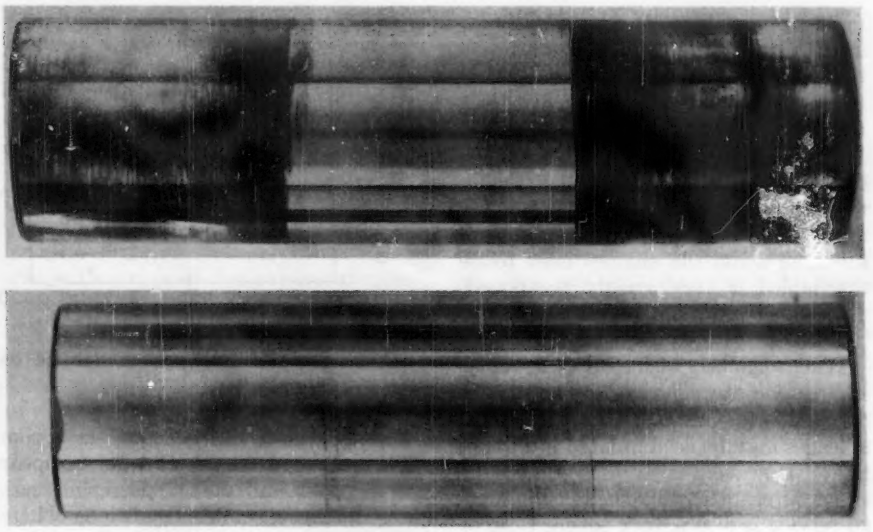


Fig. 8.—Piston Pins from Two Tests.

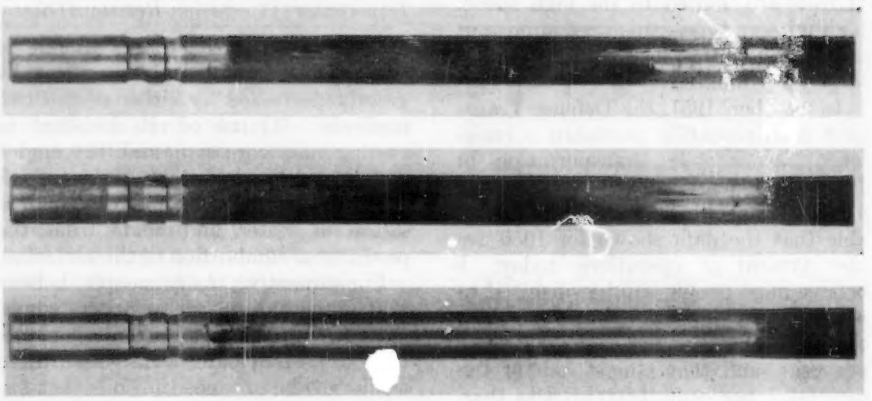


Fig. 9.—Intake Valve Stems from Three Tests.

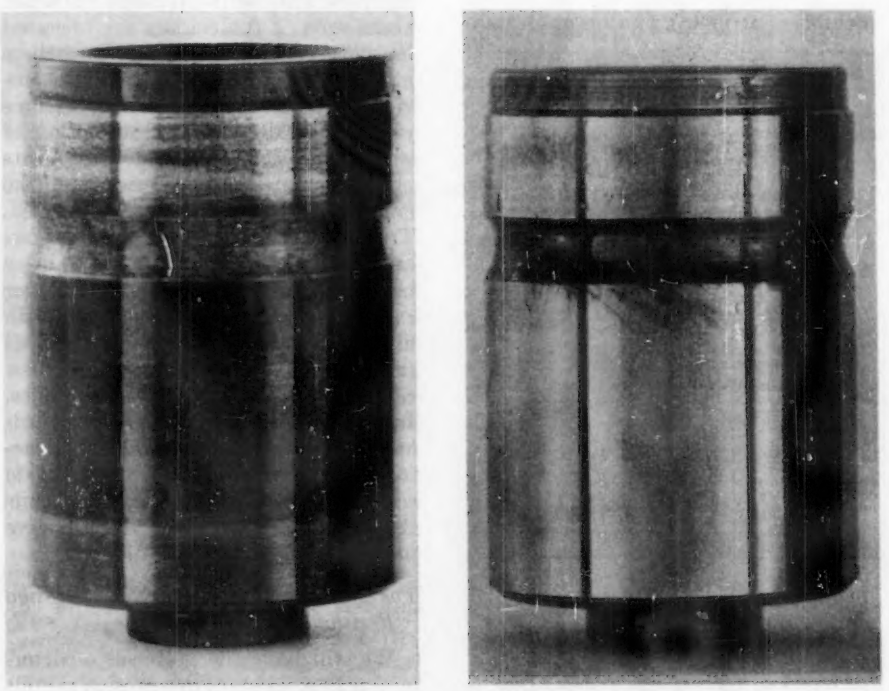


Fig. 10.—Pistons from the Hydraulic Valve Lifters from Two Tests.

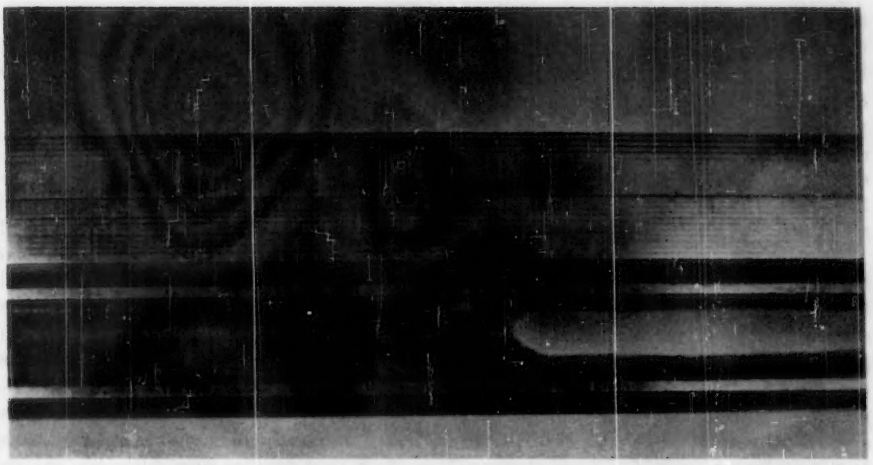


Fig. 11.—Piston Rings from a Typical 100-hr Test.

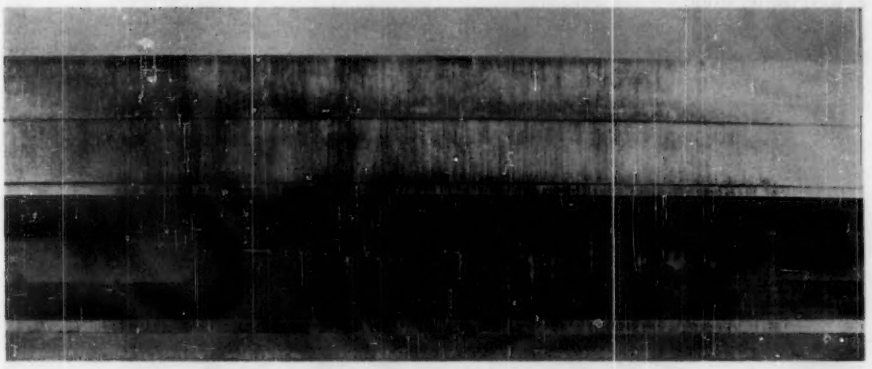


Fig. 12.—Bad Ring Wear and Scuffing.

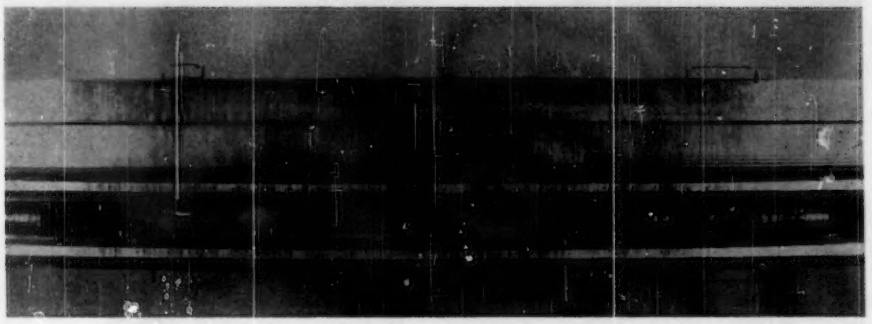


Fig. 13.—Rings from Test on 20W Oil C.

lubrication with a high safety factor; however, under special conditions such as rapid break-in, using high speed and power output, a critical loading may be attained to such an extent that fluid and boundary lubrication are inadequate, permitting incipient metal to metal contact leading to ring or cylinder wall scuffing. Under these conditions the sulfur, phosphorus or sulfur-phosphorus types of addition agents are beneficial, and the types of these compounds previously discussed in connection with oxidation stability and bearing corrosion protection also contribute a secondary action of increasing 'film strength.' These additives do not form a ferrous sulfide or phosphate film on the ring or cylinder wall surface at temperatures of normal operation. However, when temperatures rise rapidly at conditions of incipient metal-to-metal contact a metal sulfide or phosphate film may be formed, and thereby provide an increased factor of protection.

". . .Likewise, the film forming activity of sulfur or phosphorus-sulfur compounds may be disturbed by detergent additives. Hence, this property also requires careful balancing. In some cases, with high detergent oils, it is necessary to add not only additional anti-oxidant, but also definite catalyst poisoning and film forming materials in order to make the oils both oxidation resistant and non-corrosive to alloy bearings."

For many years, the possibility of high film-strength crankcase oils has been recognized, and for many years certain oil companies have been stressing the importance of this property. However, it is only recently that this subject has been receiving very much attention. In fact, it is usually difficult to illustrate the need of these properties in most engines which were designed before World War II, but with the newer higher compression engines designed more recently, these properties may be very important. One of the tests which is regularly made by automobile engineers whenever a change in design in an engine is considered is the "100-hr full load full speed" test. Engineers consider that no change in any detail should be made in an engine until it has been established that the change will not be objectionable from the standpoint of durability as shown by this test.

Figure 11 shows the piston rings from a typical 100-hr test using a commercial heavy duty SAE 20-20W oil regularly used in one of our Car Division Engineering Departments. This oil is widely marketed at filling stations. For convenience, we will call this oil, oil A. Note that the tool marks are still visible on both the top and second compression rings at the end of the 100-hr test. Similar results are also obtained in other General Motors Car Divisions using oil A in either the 10W or 20W grades.

Last summer, in making our tests on the new SAE 5W oils which were introduced last winter, a 100-hr full load, full speed test was made on one of the commercial SAE 5W oils, which we will call oil B. Figure 12 shows the bad ring wear and scuffing obtained in this test with this particular SAE 5W oil. However, when a 100-hr full load, full speed test was run on another SAE 20-20W oil, which we will call oil C, and equally bad wear was obtained, it was apparent that the trouble was not due to viscosity, but was due to lack of extreme pressure properties in both the SAE 5W oil B and in the 20W oil C. The rings from this test on the SAE 20W oil C are shown in Fig. 13. Oil C, like oil A, is also a widely distributed first line housebrand oil.

Other engine parts in addition to piston rings and cylinder walls may be adversely affected by crankcase oils lacking in extreme pressure properties. Figure 14 shows the rocker arm shaft from the 100-hr test on the 20W oil C. Figure 15 shows the rocker arm mating with the end bearing shown in Fig. 14. Attention is called to the lump in the bottom of the rocker arm bearing. This lump is the result of the metal

wearing away on the rubbing surfaces of the bearing, thus permitting the metal which mated with the oil groove in the rocker arm shaft to remain. Wear of this nature does not occur using oil A in either the 10W or 20W grades.

Other engine parts which may show excessive wear with oils lacking in extreme pressure properties are the cams and valve lifters. Figure 16 shows three tappets. Tappet No. 1 was run 500 hr using the SAE 10 oil A in a test made at 2000 rpm, no load. Experience has shown that this is a very satisfactory test procedure for evaluating wear on tappets. The wear was only 0.0004 in. This is very satisfactory. Tappet No. 3 was run on the same 2000 rpm test, but oil C in the SAE 10 grade was used. After only 100 hr, the test was discontinued because of the bad wear which was $4\frac{1}{2}$ times as much in only $\frac{1}{5}$ of the time. Tappet No. 2 is from a privately owned car after 10,000 miles of service on the road, using oil B in the 5W grade. The "soup-bowl" formed in the bottom of this tappet is the result of a loss of crowning of 0.0035 in. with probably a much greater total wear. As soon as oil company B, making the SAE 5W oil, learned of these bad wear results, they changed the additive in the oil and they are now in production on a revised SAE 5W oil which our tests show to be very satisfactory in respect to wear of valve tappets and other engine parts. The results of a 100-hr test on this SAE 5W oil B with the revised additive are shown in Fig. 17. This test was the 2000 rpm, no load test.

This improved performance on this revised SAE 5W oil B was checked by a 7700-mile test run in a 1953 engine of the same make as the one used when the bad wear shown in Fig. 16 was obtained. This road test was made in the southwestern part of the country in the month of May, 1953. The low wear results, predicted from the engine tests made at the laboratory, were confirmed by this road test.

In addition to this tappet test shown in Fig. 17, and the 7700-mile road test, additional tests were made in other engines. Figure 18 shows the tool marks remaining on the rings after a 100-hr full load, full speed test in the same type of engine as used in making the tests shown in Figs. 11 to 15, inclusive.

As soon as oil company C, producer of the oil which showed the bad wear in the SAE 10W and 20W grades, learned of the bad wear caused by their oils, they also changed the additive in their oils. Our tests on oil C show that they also have now overcome this trouble.

These tests show that under certain severe operating conditions, especially at high loads or speeds, high film strength or extreme pressure properties may be important in crankcase oils, and that even SAE 5W oils, which have the proper additives, may be very much superior in wear resistance to other oils, even SAE 10W or SAE 20W, if these other oils do not have the proper additives.

Fortunately, most of the commercial heavy duty oils are made by using the types of additives mentioned in *Lubrication*, which impart extreme pressure properties to the oils, but in some oils the additives may not be of the type to produce extreme pressure properties, and in other oils the various additives may not be properly balanced to produce the desired results. This subject is well understood by the additive manufacturers, so it should not be much of a problem for the oil companies whose oils do not have extreme pressure properties to correct this trouble, now that the importance of these properties is recognized.

Conclusion:

In conclusion, it appears that the factors involved in corrosive wear are well known and that the theories developed as a result of laboratory tests have been verified in service tests in individual cars and in fleets in actual service on the road. The operating conditions in which corrosive wear may be serious are typical of stop-and-go and intermittent service. Until recently, it has been generally believed that crankcase oils do not require high film strength or extreme pressure properties, but recent work has shown that especially in high speed or high load service these properties may be very important. Sufficient

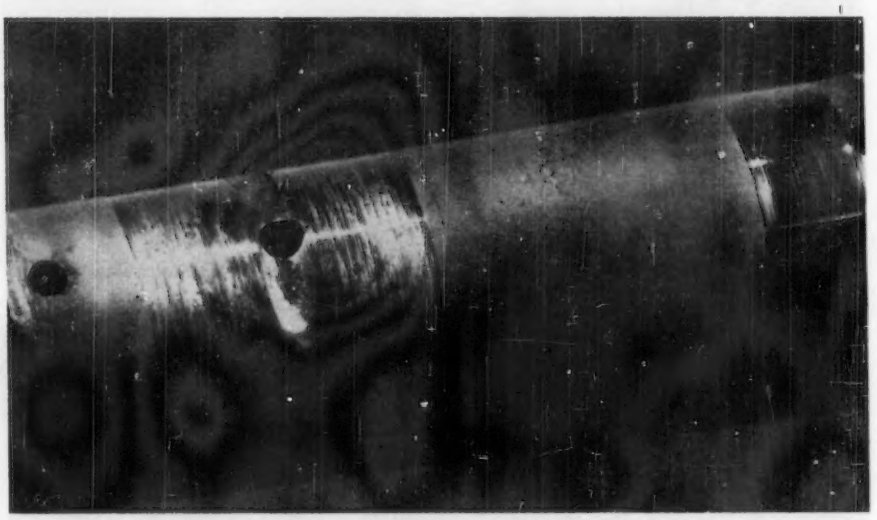


Fig. 14.—Rocker Arm Bearing.

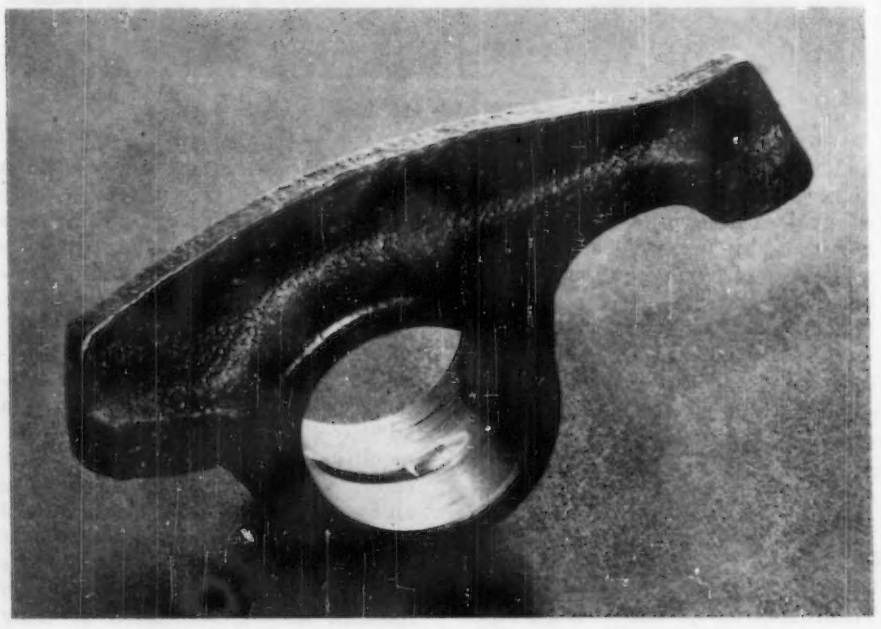
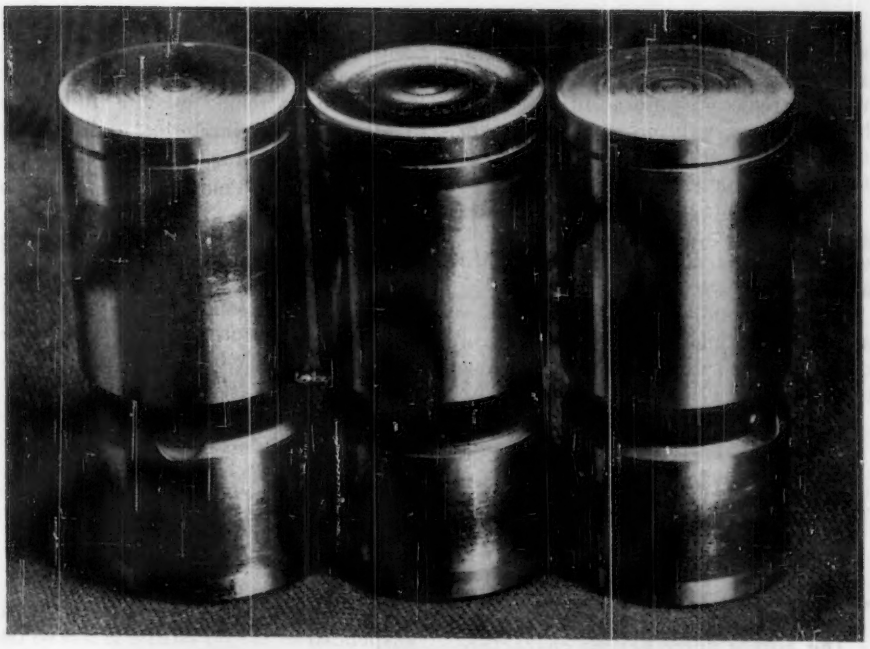


Fig. 15.—Rocker Arm Mating with End Bearing Shown in Fig. 14.



No. 1 No. 2 No. 3

Fig. 16.—Tappets.

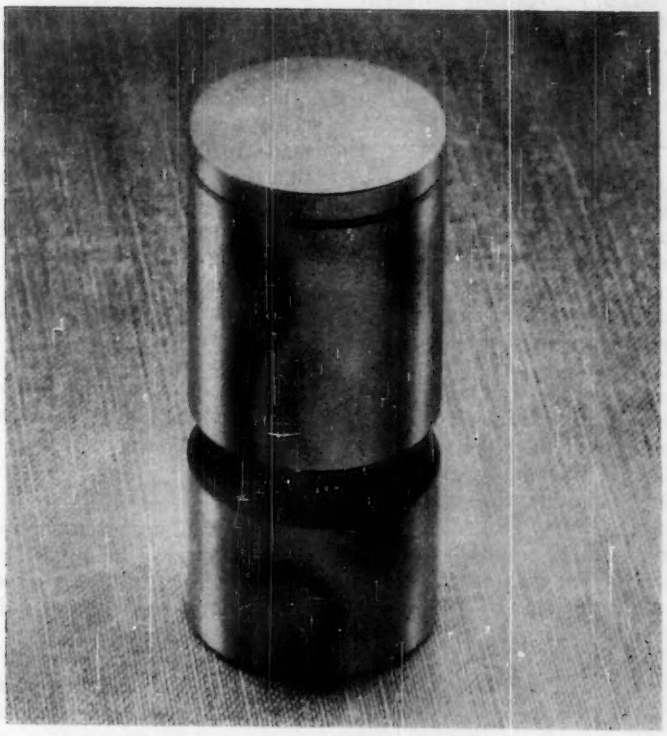


Fig. 17.—After 100-hr Test on 5W Oil B with Revised Additive.

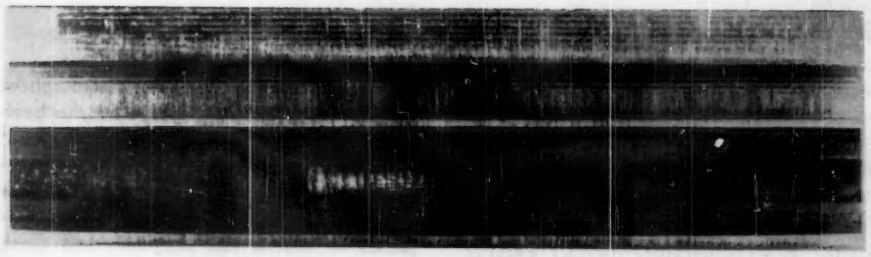


Fig. 18.—Tool Marks on Rings After 100-hr Full Load.

laboratory work has been done on the problem of high film strength oils to permit development of theories, but since it is only recently that the importance of high film strength has been generally recognized, there should be more work on this subject in individual cars and in fleets in actual service on the road. Until this experience in actual service has been obtained, we will be unable to correlate the various laboratory tests and engine tests for high film strength with the needs of the engines of various designs and with the various operating conditions, and the oil companies will not know just how high in film strength the oils should be for use under the different conditions encountered in actual service on the road.

APPENDIX

Special test to compare oils in respect to their ability to decrease rusting and corrosion:

Engine[a]	Chevrolet Powerglide
Speed	1500 rpm
Load	25 bhp
Water	
In	85 F
Out	95 F
Oil	120 F
Fuel	Commercial premium gasoline containing 2.5 to 3.0 cc of TEL
Air-fuel ratio	14.5 to 1, ± 0.5
Time[a]	21 hr of engine operation on a cycling schedule of 3 hr running and 3 hr shut down during 16 hr out of a 24-hr period; engine is shut down during the third 8-hr shift of each 24 hr

[a] The louvers in the rocker arm cover are closed to decrease ventilation and thus to increase the tendency for rusting in this test procedure. New rocker arm shafts, intake valves, valve lifters, and piston pins are used in each test. The oils are compared by photographing the rocker arm shafts, intake valve stems, valve lifters, and piston pins from each test. The intake valve stems are soaked overnight in varnish remover to remove any varnish on the stems so that the photograph will illustrate the amount of rusting and corrosion. The hydraulic valve lifters are disassembled after the test so that the photographs show the appearance of the hydraulic valve lifter pistons as well as the outside of the complete unit. If the original unit is "phosphate coated," the photograph of the "phosphate coated" part may be eliminated, as it would not be indicative of the amount of rusting and corrosion.

Since the nature of the gasoline used in making the test affects the results, the same gasoline should be used in tests comparing two different oils. In addition, if the test is not sufficiently severe, with the particular gasoline used, it may be necessary to increase the time beyond 21 hr of engine operation in order to obtain sufficient rusting or corrosion for purposes of comparison.

DISCUSSION

MR. C. M. HEINEN.[1]—I would like to supplement the paper by discussing some experience obtained with chilled-face cast iron tappets. I have circu-

[1] Engineering Division, Chrysler Corp., Detroit, Mich.

lated three tappets among you. Tappet No. 1 shows severe chemical corrosive attack of the type commonly called fatigue. Tappet No. 2 shows scuffing and fatigue. Tappet No. 3 looks very good.

All three are examples of tappets removed from a test which is used at Chrysler Corp. to evaluate tappet materials. The test consists of running a DeSoto engine at 1200 rpm for 2 hr, then stopping for 1 hr. The engine is standard except that the springs have a 50 per cent overload.

The variable in the test of the tappets was the type of lubricant. Tappet No. 1 operated in an engine using an oil with extreme pressure additive, which has been successful on steel tappets in the Cadillac test. The condition of this tappet represents 40 hr of operation.

The second tappet came from an engine using an experimental modification of one of the commercial oils. This also represents 40 hr of operation.

Tappet No. 3 shows the condition after 80 hr of operating with the base oil used in Tappet No. 1, but without any of the additives.

We are not yet quite certain what all this means, but it most certainly indicates that certain additives used for increased extreme pressure resistance and oxidation inhibition will attack tappets of certain materials. We intend to continue our work on materials with oils as one of the major variables, and hope to develop a material that will not be sensitive to variables in oils. Meanwhile, we hope that you will add chemical corrosion to the list of problems which must be answered by modern crankcase oils.

Wear in Bearings

By Charles H. Junge

The author describes the characteristics of the various types of wear encountered in sleeve bearings under many conditions of service, and outlines methods of recognizing different types of bearing failures as well as corrective measures which can be employed to eliminate or reduce sleeve bearing troubles.

WHEN a manufacturer of sleeve bearings sees his product returned from field service showing any appreciable wear, he can be reasonably sure that the bearing was improperly designed or improperly used.

A bearing when running under ideal conditions of full hydrodynamic lubrication with no metal-to-metal contact should not be expected to experience wear in the usual sense. True, under conditions of starting from rest or stopping after running, these conditions are not fulfilled. There are other conditions which prevail to cause bearing wear, but in most instances when wear does occur, a breakdown of the oil film takes place and metal-to-metal contact ensues. These will be dealt with in detail later.

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

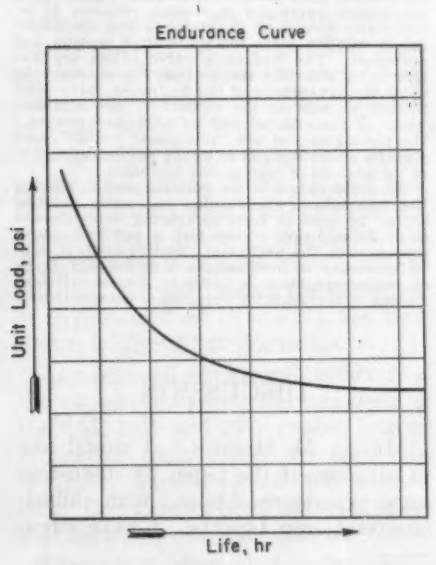


Fig. 1.—Bearing Life *versus* Load.

There are at least two causes for bearing wear not covered by the above and not brought about by filterable material in the oil stream. One of these is corrosion, which is a chemical or physicochemical attack of the bearing metal by reactive substances in the oil stream. The second, erosion, is more of a physical or mechanical destruction of the bearing metal particle by particle.

Sometimes erosion may be considered as simple as the washing away of soil by a fire hose. In other cases it is much more complex and may be tied up with pressures fluctuating rapidly from extremely high positive values to those approaching a fair vacuum.

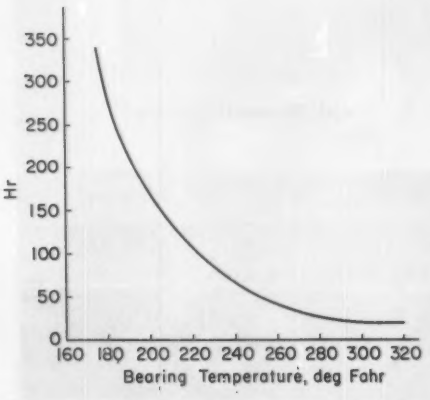


Figure 2.—Temperature *versus* Fatigue Life.

Wear caused by filterable particles suspended in the oil stream is not to be considered here. This rules out the most common cause of bearing wear and bearing failures, since by far the greatest enemy of sleeve bearings is dirt and foreign particles. This paper will not deal with such failures, but will center around typical failures from other causes and methods used to overcome such failures. No attempt will be made to discuss lubricants or lubrication theory, since they are far removed from the author's experience and are best left to the experts in those fields.

Bearing failures can be classified under the following general headings: (1) fatigue; (2) scoring, wiping, seizure; (3) corrosion; (4) erosion.

In all of these failures, wear of the bearing metal occurs, sometimes in large amounts, and sometimes in quite small amounts.

Fatigue:

Fatigue failures are probably the most common type of failure in sleeve bearings, at least in automotive service. Such failures begin as fine radial cracks which progress down through the bearing lining to the bond line. Later such cracks spread circumferentially until they meet with other radial cracks,

The Author . . .

CHARLES H. JUNGE, Plant Metallurgist at The Cleveland Graphite Bronze Co., has been engaged in research and development activities, metallurgical quality control, and production problems for nine years. He has studied the behavior of many bearings, subjected to special test programs, and those returned from field service.

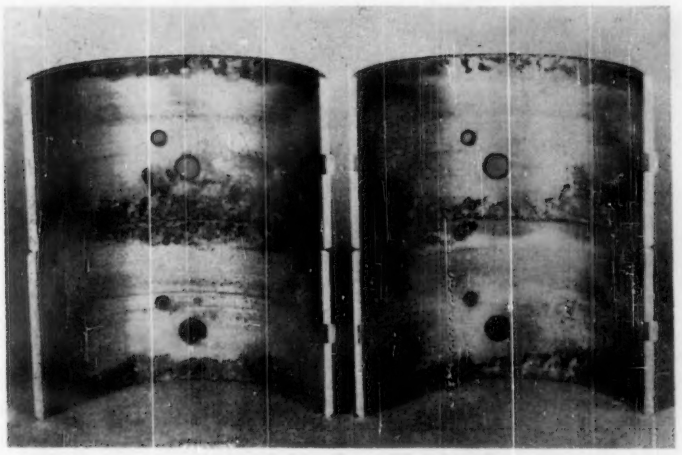


Fig. 3.—Fatigue, Hour-Glass Journals.

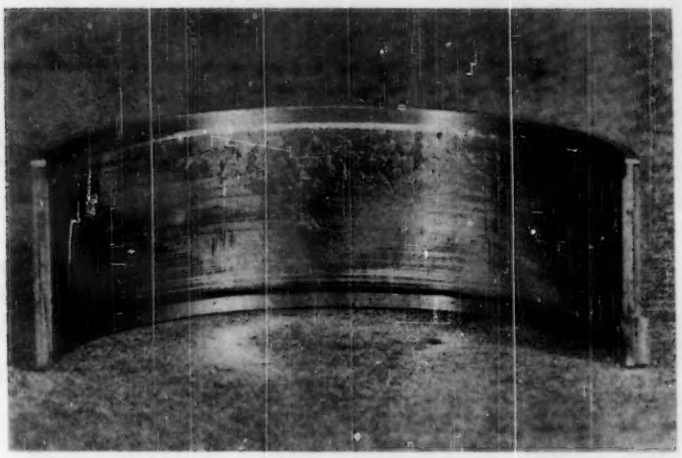


Fig. 4.—Fatigue, Edge Loading.

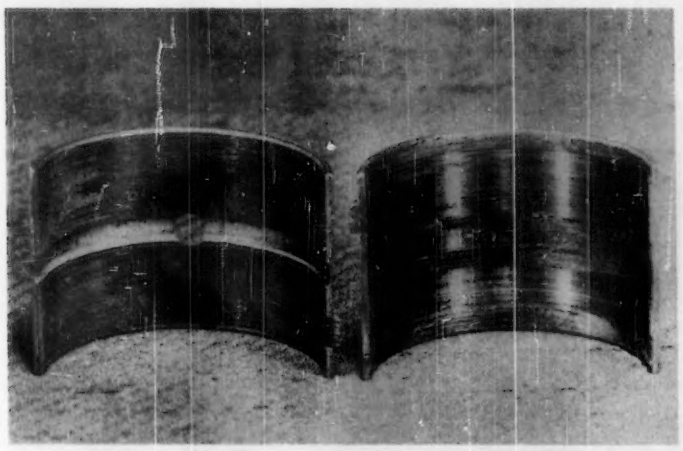


Fig. 5.—Wiping, Insufficient Initial Clearance.

thus creating a loose piece of lining material.

Eventually these loose pieces become broken down to such a small size that they can enter the clearance zone between the shaft and the original bearing surface. Much of such fine material is transported by the oil stream, some to be redeposited on the same bearing a short distance away and some on other bearings in the same engine, some to be trapped in the oil filter and sludge pockets in the crankcase. But, as the fine particles from initial fatiguing are deposited on other areas of the running surface, clearances are lowered and unit loading and temperature locally increased, thus causing premature fatigue in these new areas. Fatigue thus can become a self-accelerating process.

Figure 1 shows diagrammatically the general shape of the load-life curve for a sleeve bearing, which indicates how life may be lowered by an increase in unit loading. Figure 2 demonstrates how rapidly fatigue life can fall off with increasing operating temperature.

It now becomes clear why fatigue may be self-accelerating, since the debris from the initial damage when deposited on undamaged adjacent areas creates local spots of high load intensity as well as high surface temperature from loss of proper clearance.

In many cases, fatigue failures begin because of some mechanical misalignment, improper assembly, or dirt or chips in the oil stream or behind the bearing back, thus preventing proper seating of the back in the case bore. Improper clearances caused by hour-glass journals (Fig. 3) or edge loading (Fig. 4) from a tapered shaft are frequent causes of premature fatigue failures. It should be remembered that such failures occur primarily because of load concentration and secondarily because of high operating temperature.

Wiping and Seizure:

Wiping is a scrubbing type of wear which occurs in a bearing when the oil film is interrupted or becomes so thin that metal-to-metal contact can take place. If this condition is temporary, little damage may result. If it is frequent or sustained, considerable progressive damage will occur, leading eventually to complete destruction of the bearing and sometimes the journal.

Seizure, or actual welding of the bearing surface and journal, can take place only if the frictional heat generated is sufficiently great and if the torque is less than the strength of such a welded interface, assuming that the bearing is prevented from turning in its case. Seizure in the low-strength - low-melting babbitt bearings is therefore much less likely than in copper-lead bearings. Sometimes the steel back of babbitted bearings will weld to the journal at a late stage of failure when the babbitt is completely wiped or melted out.

Figure 5 illustrates a wiped bearing surface that was caused by insufficient initial clearance so that it was impossible to establish a proper oil film between the journal and the bearing surface. In such cases, an investigation of the dimensions of the mating parts and operating temperatures is required. Simple measurements of the bearing wall do not tell the whole story. Accurate measurements of the bearing assembled in the bore should be made, since the press fit of the bearing can be expected to enlarge the diameter of the bore to give greater clearances than those obtained by theoretical calculations. Sometimes, because of the peculiar

geometry of the case design, an out-of-round condition produced by non-symmetric elastic distortion of the case by the press fit may be present after bearing installation. In some instances this may be compensated for by the design of the bearing, while in others a redesign of the housing is required.

The lack of proper clearance can also be produced by misalignment or cap shift in assemblies that are otherwise dimensionally satisfactory. In connecting rod bearings at high speed, the increased inertia load acting in tension may distort the bore of the rod so that the horizontal clearance is reduced sufficiently to cause a pinching off of the oil supply and momentary metal-to-metal contact. In such a situation, "eccentricity," or a slight gradual thinning of the bearing wall in the vicinity of the parting line, may remedy this trouble without the need for redesigning the rod.

Journal finish that is too rough for the particular type of bearing alloy is another cause of the wiping sort of defect. Figure 6 shows damage to copper lead caused by a rough grind finish on the mating journal.

On certain cast iron shafts, special lapping or chemical surface preparation methods seem to be necessary. In such cases, the microfinish of the shaft does not necessarily furnish the criterion that indicates operating success or failure.

Wiping of the bearing material sometimes provides enough clearance so that the bearing can operate thereafter in a satisfactory manner. Babbitts are able to adjust themselves better to such a situation than the harder copper leads. However the relief obtained in some cases is insufficient to allow operating temperatures to be established at normal levels, so that, while the wiping action progresses no further, the lining fails prematurely from fatigue.

Corrosion:

Corrosion of bearing surfaces occurs because of the presence of reactive chemical substances in the oil stream. The rate of this corrosive attack can be expected to increase as operating temperatures rise above normal for two reasons: (1) The reaction rate of any chemical reaction increases with temperature. (2) Increasing oxidation of the lubricants increases the concentration of the corrosive agents.

However, operation at subnormal temperatures may also lead to the formation of increased amounts of other corrosive agents by the interaction of the products of fuel decomposition and crankcase condensate.

There is much evidence to indicate

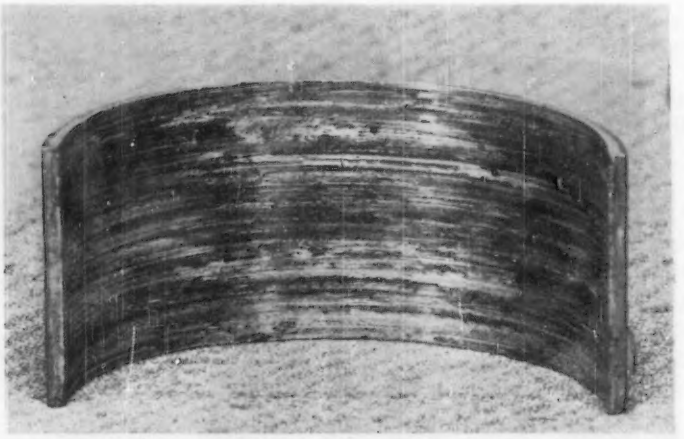


Fig. 6.—Wear, Rough Journal.

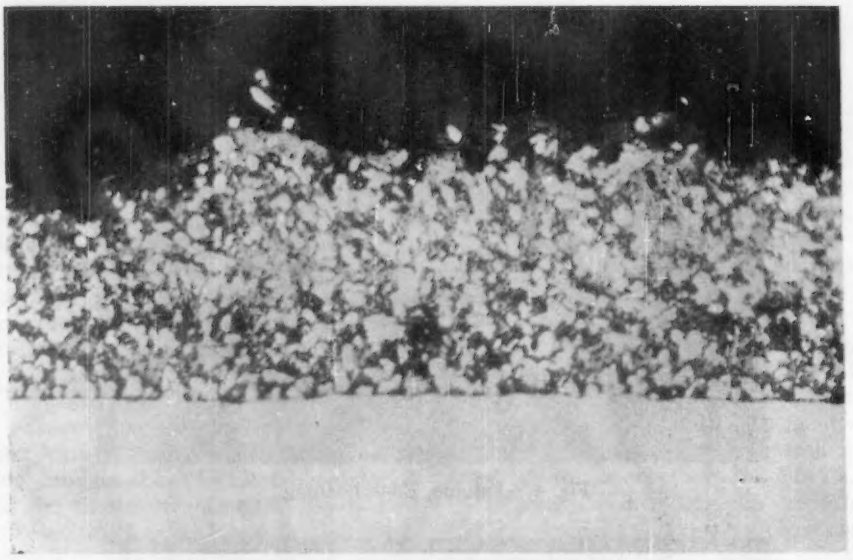


Fig. 7.—Microsection Through Corroded Lead Base Babbitt (× 500).

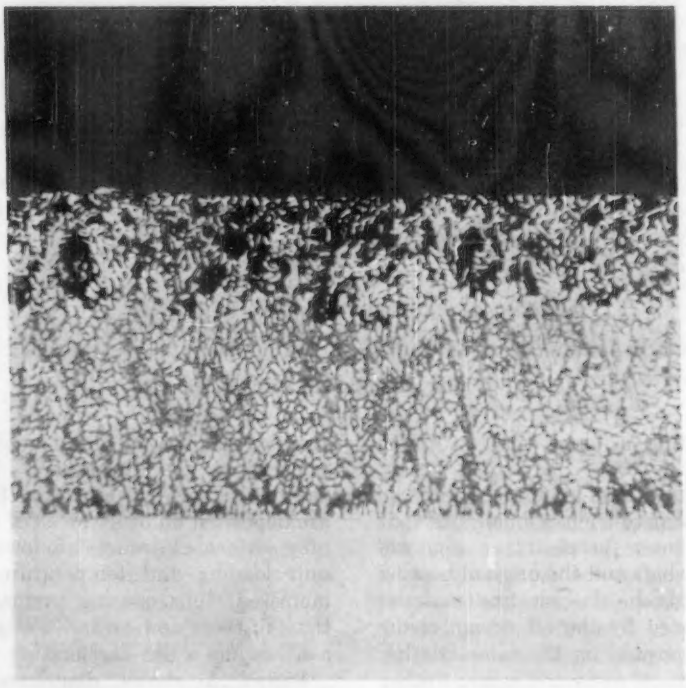


Fig. 8.—Microsection Through Corroded Copper Lead (× 100).

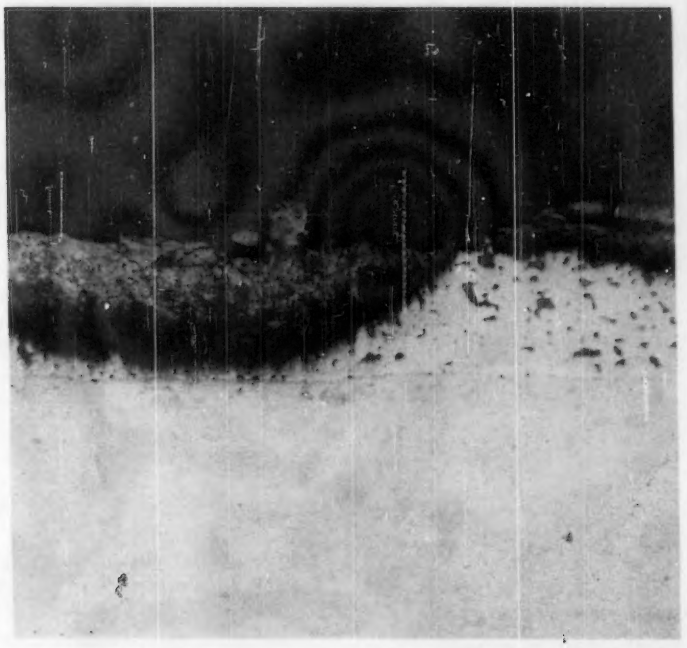


Fig. 9.—Microsection Through Corroded Leaded Tin Bronze (× 100).

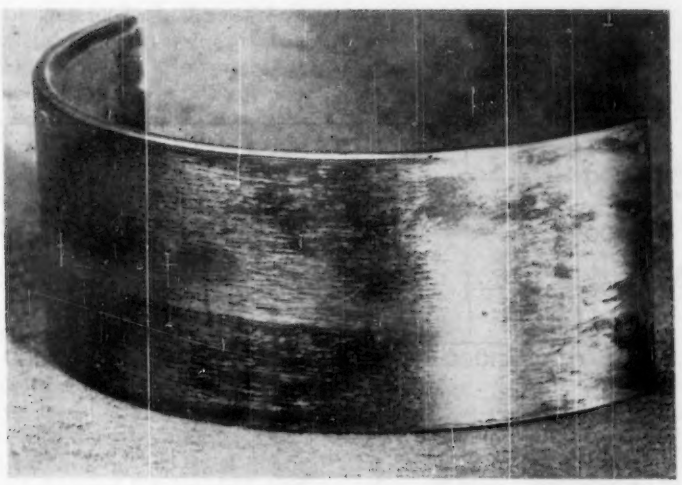


Fig. 10.—Fretting Corrosion on Steel Bearing Back.

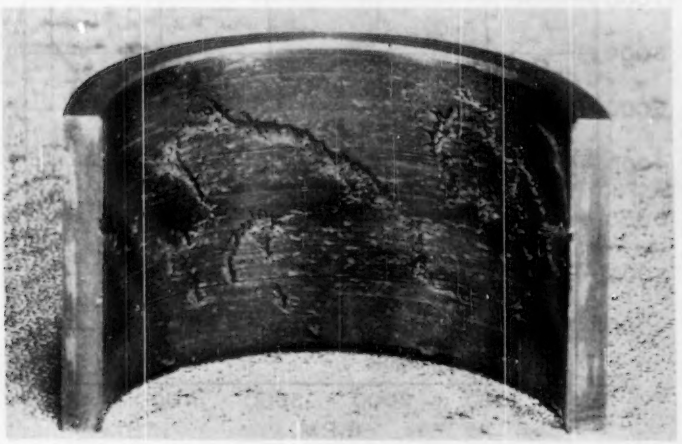


Fig. 11.—Cavitation Erosion in Gear Train Bushing.

that corrosion of bearings is not a simple chemical reaction that can be easily simulated by a laboratory beaker test.

Perhaps the actual surface temperature of the bearings and the oil, the high pressures or the rapid variation of pressure in the hydrodynamic wedge, the destruction and removal of protective films, and the concentration changes brought about by the velocity of the oil stream all play important rôles in vitiating such tests.

Corrosion of tin-base materials is rarely observed. In lead-base babbitts, the lead is preferentially attacked, leaving the harder, less soluble compounds standing in relief. After sufficient attack, these particles may be rubbed off on the fingers as a grayish powder. The appearance of a section through such a surface at 500 diameters is seen in Fig. 7.

When corrosion occurs in bare copper-lead bearings, the lead phase between the copper crystallites is preferentially attacked. This undermining of the structure leads to a general weakening so that fatigue failures may rapidly follow. Sometimes it is difficult to determine the exact sequence of events, even when metallographic, X-ray, and fracture analysis are all employed. Figure 8 illustrates corrosive attack in copper lead.

To combat corrosive deleading, a protective corrosion-resistant precision electrodeposited overlay 0.001 in. thick is used. The base metal in this overlay is lead, but marked corrosion resistance is imparted by the codeposition of tin with the lead. To prevent diffusion and loss of this tin to the underlying intermediate layer of copper-lead material and to act as an additional barrier to the corrosive agents should the lead overlay be destroyed, a thin nickel dam is deposited on the copper lead prior to the lead overlay plate. This is the standard construction for millions of automotive bearings now giving unusually satisfactory service.

Figure 9 illustrates a very unusual situation in a high-tin leaded bronze used in a piston pin application where corrosive attack has not been confined to the lead phase alone. The entire nonferrous portion has been eaten out down to the steel in some areas. X-ray diffraction analysis indicated that sulfides and bromides of both copper and lead were present in the dark corrosion product.

A still different type of corrosion known as fretting corrosion occurs. Fretting is a general characteristic of all mating parts that are subject to microscopically small relative motion. In bearing applications such as king-pin bushings or axle bearings which are subject to

high-frequency vibrations, the lubricant film may break down, allowing microscopically small areas of the two metal surfaces alternately to weld together, then tear apart. When the mating surfaces are oxidizable, as are most metals, fine powdery metal oxides are produced by the fretting action, and the process is more specifically known as "fretting corrosion." Fretting corrosion may sometimes be observed on the backs or parting line surfaces of bearings that have moved in their housings because of insufficient press fit or excessive elastic distortion of the bore under peculiar conditions of service, as illustrated in Fig. 10.

Erosion:

Infrequently, cases are observed where the bearing surface has simply been washed away by the oil stream, leaving a "hen-tracked" pattern. Under other conditions, a less understood mechanism known as "cavitation erosion" takes place. The classical theory of cavitation requires pressures fluctuating rapidly from a high to a low or negative value. Conditions in a high-speed gear train might be expected to fulfill these requirements, as well as other applications where relatively high rotational speed is associated with high-frequency shock leadings, and these are in fact the places where this type of wear has been most frequently encountered.

Figure 11 is a cut-open section of a bushing from such a gear train which shows the pattern popularly designated as "cavitation erosion." Such damage may be distinguished from fatigue by the absence of cracks and the much smoother sides and bottom of the eroded areas.

Figure 12 shows subsurface cracks in a plated lead overlay undergoing similar erosive damage, where the metal appears to be disintegrating into small microscopic particles.

Changes in the pattern and velocity of the oil flow brought about by alterations in oil grooving or bearing eccentricity, viscosity of the lubricant, or minimizing the intensity of shock loading by better tooth engagement have sometimes helped to eliminate this type of erosion, but it is often a trial and error proposition. Changing the type of bearing alloy usually affords little if any relief from such trouble.

Design to Prevent Bearing Failure:

It was suggested at the beginning of this discussion that a bearing which wears was improperly designed or improperly used. The maker of a bearing usually has no control over the second

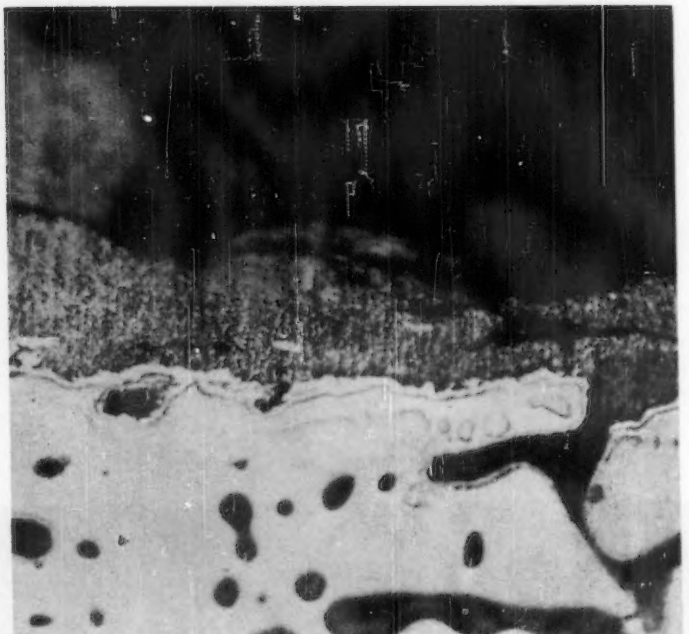
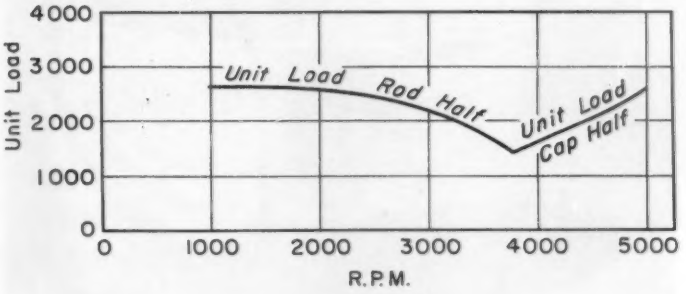


Fig. 12.—Microsection Through Cavitation Erosion of Plated Overlay (× 500).



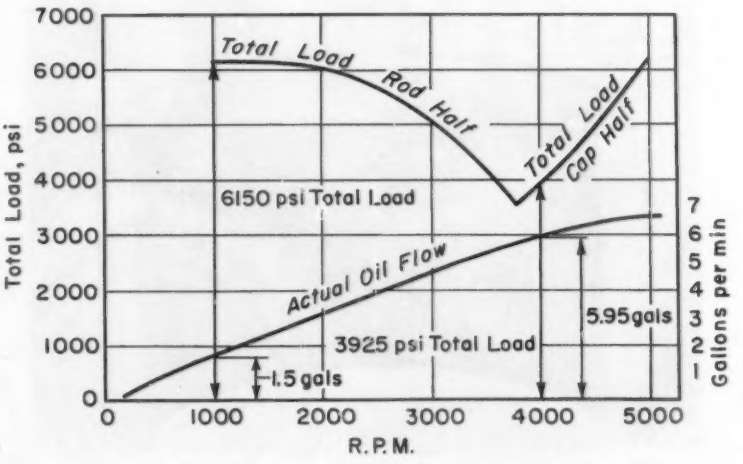


Fig. 13.—Bearing Loads and Oil Flow *versus* Engine rpm.

factor, and not always complete control of the first. It seems appropriate to outline briefly how proper design at an early stage in the evolution of a bearing can aid in preventing or at least postponing bearing failure.

The first requirement in bearing design is a knowledge of the bearing loads under various conditions. Methods of determining these loads have been pretty well worked out by the mechanical engineers, who take into account the forces arising from gas pressure and mass inertia of the reciprocating and rotating parts.

Such information is summarized in Fig. 13 where we have bearing loads and oil flow plotted against engine rpm for a connecting rod application. At low loads and with wide open throttle, a "lugging" condition exists where the peak gas pressure load is thrown on the rod half of the bearing when oil flow is critically low. It is perhaps not unexpected that fatigue failures occur under these conditions where heat dissipation through oil flow is restricted and unit loads are a maximum.

This diagram further illustrates the falling off of unit load on the rod half until it equals the increasing inertia load on the cap half. However, the oil flow now has greatly increased, permitting lower bearing operating temperatures, so that fatigue failure is less probable until very much higher speeds are reached. The cap half of the rod under these conditions then becomes the more vulnerable to fatigue failure.

From the results of such a study, it may be possible to make at least a preliminary selection of the proper bearing material to withstand the necessary loads. Figure 14 gives some idea of the relative load-carrying capacity of bearings with different constructions.

A lubrication study is next made. The object is to establish bearing clearances under operating conditions such that sufficient oil film thickness is established and a low enough bearing temperature to give the desired life is obtained. Figure 15 shows graphically the results of such an investigation. By these means the bearing design specialist can reasonably predict the behavior of various bearing designs and thus avoid costly and time-consuming cut-and-try methods.

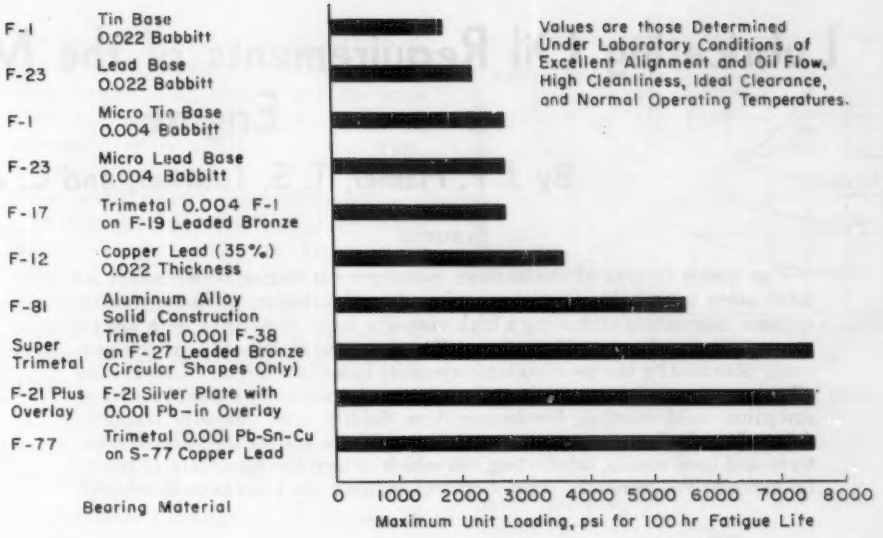


Fig. 14.—Relative Load-Carrying Capacity of Various Bearing Materials.

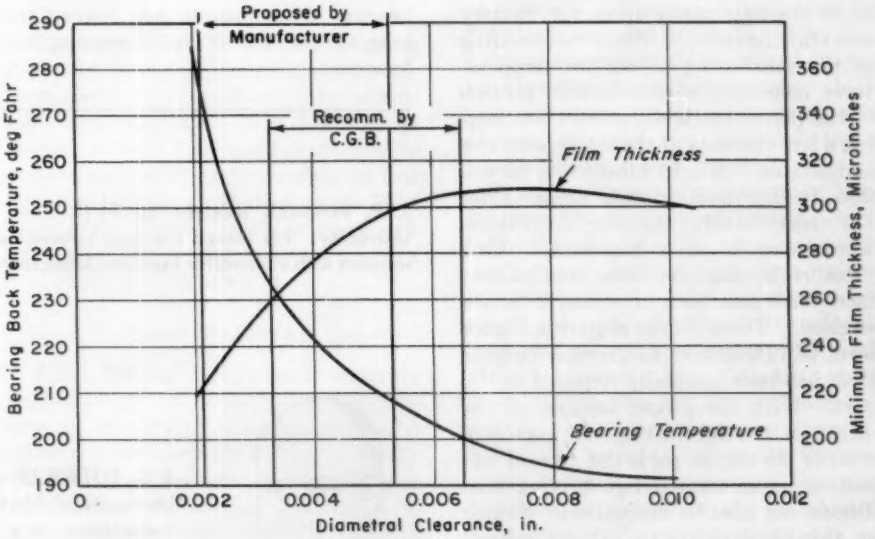


Fig. 15.—Oil Film Thickness and Bearing Temperature *versus* Clearance.

Lubricating Oil Requirements of the Modern Automotive Engine

By J. P. Hamer, T. S. Tutwiler, and C. A. Weisel

SYNOPSIS

The design factors of the modern passenger car engine which affect its lubricating oil requirements are reviewed in this paper. This engine requires a lubricating oil having a high viscosity index to achieve both low oil consumption and easy cold starting. The desired high viscosity index is generally obtained by the use of suitable viscosity index improvers. Lubricating oils containing satisfactory viscosity index improvers are excellent in oil consumption, cold starting, low-temperature fluidity, and viscosity stability. A benefit in fuel economy is also achieved. By the proper selection of additives and base stocks, lubricating oils which reduce the formation of harmful deposits and minimize wear of critical engine parts have been developed.

THE modern automotive engine is a finely tooled mechanism built to extremely close tolerances. It delivers more power, it runs more auxiliary equipment, and it has a higher compression ratio than did engines of a decade ago. This engine imposes more stringent requirements on the lubricating oil than did its predecessors and, therefore, requires a new level of lubricant performance.

Because of its higher compression pressures and its additional auxiliary equipment, the modern engine requires more starting power from the battery and starting motor. Since viscous drag of the lubricating oil at low temperatures consumes a considerable portion of the power available, a lubricant having a low viscosity at these temperatures is desirable. A light lubricating oil will flow readily into friction areas under low temperature starting conditions, when wear is at a maximum. Unit pressure loadings on some friction surfaces have also been increased in newer engines. These points require a higher level of lubrication to prevent failures than has been generally required in the past. With the proper balance of additive in the lubricating oil, corrosive wear of the engine parts due to acid formation under stop-and-go driving conditions can also be minimized. Sludge or varnish deposits in various critical areas interfere to a greater extent than previously with the satisfactory operation of automotive engines. The formation of sludge under conditions of low temperature stop-and-go driving can be controlled by the use of suitable additives in the lubricating oil. Similarly, a high degree of oxidation stability and detergency can be achieved to prevent varnish and sludge deposits from forming.

For several decades workers in the field of automotive lubricants have recognized the desirability of using a lubricant of the lowest viscosity which gives adequate lubrication. Considerable data have been presented in the past showing that where low viscosity lubricants are used, friction is reduced and easier starting results. At the same time less power is consumed and greater fuel economy is achieved. Under these conditions of less friction, bearing temperatures are lower, prolonging the life of both bearing and lubricant.

Two factors which have limited the use of low viscosity oils in the past were fear of inadequate lubrication and fear of excessive oil consumption. Regarding the question of inadequate lubrication, a survey of the literature indicates that lubrication failure in the past has been associated with oils which were too thin at elevated operating temperatures. In these cases, oils having low viscosities at starting temperatures were used to provide easier starting without due regard being given to the thinning out of the oil as temperatures increased. If the oils in question had higher viscosity indices,[1] that is, if they had lost less viscosity with increasing temperature, the failures would very likely not have occurred. In other cases where lubrication failure has been associated with low viscosity motor oils, the failure resulted not because the viscosities were inadequate, but because the oil distribution systems in certain of the older engines did not

[1] E. W. Dean and G. H. B. Davis, "Viscosity Variations of Oils with Temperature," *Chemical Metallurgical Engineering*, Vol. 36, No. 10, pp. 618–619 (1929).

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deliver enough oil to the bearings, and lubricant starvation resulted.

Engine builders and piston ring manufacturers have made marked progress in design and material so that oil consumption is no longer the problem it once was. The engine manufacturer has learned how to minimize cylinder distortion.[2] He knows the importance of proper location of head-stud anchorages, deck rigidity, and the proper choice of metals to eliminate distortion due to differences in thermal expansion. Use of full length cooling jackets, overhead valve design, and better cooling water distribution has reduced oil consumption by eliminating distortion due to "hot spots." Machining methods have improved so that bores ground to 0.0003 in. are being produced.

Advances in piston and piston ring design have also reduced oil consumption markedly. Cam-ground pistons which expand properly under thermal stresses, piston skirt taper, and skirt-to-cylinder clearances are all factors recognized to have a marked effect on oil consumption. Ring grooves are made square, narrow, and deep. Oil ring grooves are provided with ample drainage to prevent damming up of excess lubricant, and piston lands are sturdy so as to be nondistorting. Finally, compression rings have been improved to reduce consumption and provide better seals against blow-by. In general, the tapered compression rings have made possible better oil control; the narrow rings have reduced flutter, which formerly was one of the causes of scuffing; and the deeper rings have provided better sealing. The use of chrome-plated rings provides additional protection against scuffing, abrasive wear, and corrosive wear. Oil control rings having improved drainage play an important role in reducing consumption.

Other improvements in engine design have also had a marked effect in reducing oil consumption. These improvements can be grouped as affecting external leakage. Bearing end seals, crankcase gaskets, cover plate gaskets, external oil connections, and crankcase breathing have all been modified to improve oil consumption.

The effect of improvements in design on reduced oil consumption is readily apparent if the oil consumption of several decades ago, which was measured in terms of gallons per 1000 miles, is compared to that of today, which is measured in quarts per 1000 miles. This is particularly striking when considering the extended high-speed driving conditions on modern super-highways, which would be expected to increase oil consumption. It should not be concluded from these remarks that oil consumption is a thing of the past. While real reductions have been effected, there is still room for improvement.

A brief summary has been given of the design trends leading to the modern engine. The following discussion summarizes the factors governing the formulation of lubricating oils capable of satisfying the requirements of this engine.

Oil Consumption

Viscosity:

Although mechanical improvements in the automotive engine have reduced the magnitude of oil consumption, the viscosity of the lubricating oil still has an important influence in this respect. Work previously reported[3] has indicated that oil consumption can be correlated with the viscosity at 300 F, other things being equal. The higher the viscosity, the lower is the oil consumption.

This relation is illustrated in Table I. However, there is undoubtedly a point beyond which further increases in viscosity do not give improved consumption.

Volatility:

The evaporation of light components in the oil at engine operating temperatures also is an important factor affecting oil consumption. It is desirable, of course, to keep the amount of volatile components as small as possible for low oil consumption, particularly with light grade oils. The volatility of an oil can be minimized by the proper choice of crude type and distillation.

Cold Starting

While the engine requires a relatively high viscosity oil at operating temperatures to obtain low oil consumption, it must be remembered that a low viscosity oil is needed at low temperatures for ease in starting. At starting temperatures, an oil with a relatively high viscosity will exert greater drag on the engine and reduce the cranking speed. A relationship exists between the oil viscosity and the lowest temperature at which the average car will start, based on a minimum cranking speed of 25 to 30 rpm.[4] This is illustrated in the borderline starting curve in Fig. 1. In order to conserve the battery and to permit

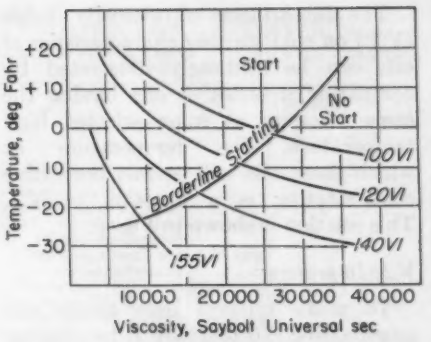

Fig. 1.—Starting Characteristics of Motor Oils.

All oils 52 SUS at 210 F.

easier starting of modern cars having higher compression pressures and many auxiliary devices, it is particularly important to use oils with a low viscosity at cold starting temperatures.

Combining Good Consumption and Cold Starting

Viscosity Index Requirements:

In a modern engine it is desirable to have a lubricating oil which combines low viscosity at low temperatures for ease in cold starting and relatively high viscosity at operating temperatures for low oil consumption. The degree to which an oil possesses this combination of viscosity properties is indicated by the viscosity index of the oil. Viscosity index is a measure of the rate of change in viscosity with temperature; high viscosity index means a slower rate of change, whereas low viscosity index means a faster rate of change.[1]

It is possible to formulate an oil having low temperature viscosities which fall within the SAE 5W motor oil classification and having high temperature viscosities which satisfy the requirements of an SAE 20 or even 30 grade oil. Such an oil would have a very high viscosity index. The following data show that as the low temperature viscosity is decreased by going from an SAE 10W to SAE 5W grade the viscosity index must increase if the high temperature viscosities are maintained at a level sufficient to insure low oil consumption. See Table I.

TABLE I.—RELATION OF VISCOSITY AND VISCOSITY INDEX TO OIL CONSUMPTION.

Data from Esso Laboratories Correlations.

SAE Grade	Viscosity Index	Viscosity, SUS		Relative Oil Consumption, per cent (Viscosity Basis)
		210 F	300 F Extrapolated	
10W[a]	100	44.6	34.8	100
10W[a]	131	56.0	39.4	55
5W[b]	100	38.3	32.5	140
5W[b]	155	50.8	38.4	60

[a] Will permit starting at −10 F.
[b] Will permit starting at −23 F.

[2] P. S. Lane, "Oil Consumption in Passenger Car Engines," *Journal*, Soc. Automotive Engrs., Vol. 58, No. 11, Nov., 1950, pp. 18–20.

[3] C. L. Fleming, Jr., B. W. Geddes, N. V. Hakala, and C. A. Weisel, "The Performance of High V.I. Motor Oils," *Transactions*, Soc. Automotive Engrs., Vol. 4, July, 1950, pp. 410–417.

[4] J. K. Appeldoorn, "Motor Oil Viscosity and Cold Starting." Presented at A.P.I. Meeting, Chicago, Ill., Nov. 6, 1948.

The importance of viscosity index (V.I.) on cold starting characteristics of oils can be strikingly illustrated by comparing a series of oils having the same viscosity at some selected high temperature. The temperature at which these oils will permit borderline cold starting is a function of V.I. This relation is shown in Fig. 1.

V.I. Improvers:

To make mineral base motor oils much above 110 to 115 V.I. by existing commercial processes, it is necessary to use V.I. improvers. These materials are special polymers which are generally very high in viscosity and increase the viscosity of base oils to which they are added. At the same time, the lubricating oil obtained has a considerably higher V.I. than does the base oil from which it is derived.

The effectiveness of motor oils containing V.I. improvers is illustrated in a typical field test. Here a V.I. improved oil was compared with a straight mineral oil containing bright stock, both blended to the same SUS viscosity at 210 F. A third, low viscosity mineral oil, which was the base stock used in the other oils, was included in the test to establish that oil consumption in the cars was sensitive to oil viscosity. The tests involved high speed driving for about 50,000 miles using a fleet of 15 passenger cars. The V.I. improved oil showed only 85 per cent of the oil consumption obtained with the oil containing bright stock, whereas the base stock showed 121 per cent of that of the oil containing bright stock. Oil inspections and test results are shown in Table II.

TABLE II.—OIL CONSUMPTION FIELD TESTS[a]—PASSENGER CARS.
50,000 Miles—High Speed Operation.

	Oil A	Oil B	Oil C
Thickener used	8% V.I. improver X	Bright stock	None[b]
Viscosity 210 F, SUS	72.0	72.4	54.7
Viscosity 300 F, SUS	43.6	43.0	38.3
V.I.	120	103	106
Flash point, deg Fahr	445	450	445
Relative oil consumption	84	100	121

[a] All the oils contain detergent and pour depressant additives.
[b] This oil was the base stock for oils A and B.

Oils formulated with V.I. improvers obviously should maintain their original viscosity and V.I. characteristics in the engine. V.I. improvers differ in their ability to keep their effectiveness after running in the engine. A loss in effectiveness is probably due to mechanical degradation of the large polymer molecules by the high shearing forces in the engine. The importance of V.I. improver stability is illustrated by

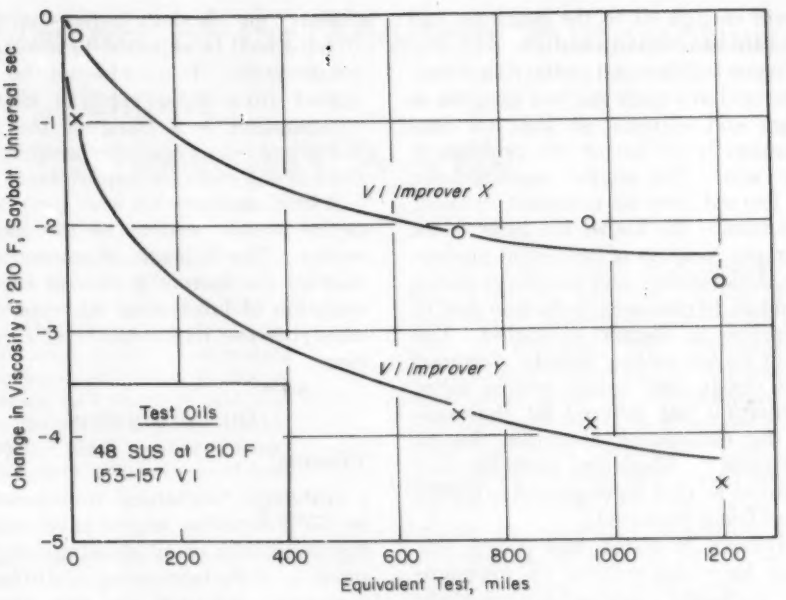

Fig. 2.—Viscosity Loss for V.I. Improved Oils in Laboratory Engine Tests.

Test conditions: 30 to 60 mph, 200 F oil sump, duplicate tests.

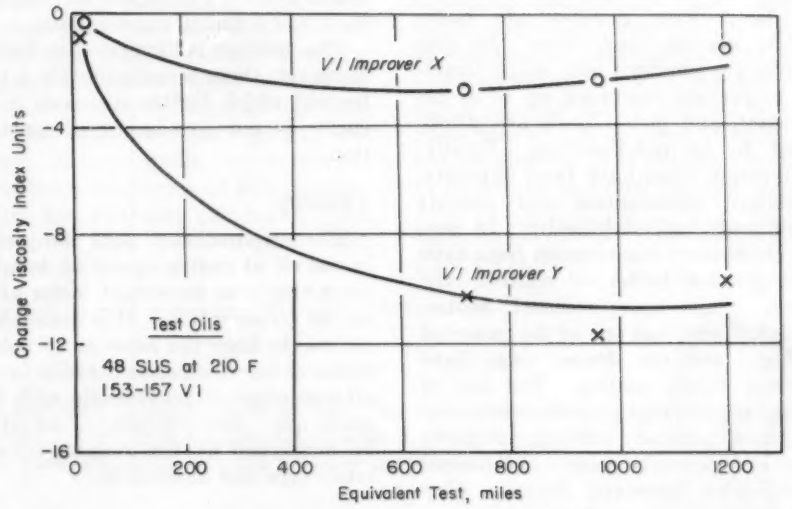

Fig. 3.—Viscosity Index Loss for V.I. Improved Oils in Laboratory Engine Tests.

Test conditions: 30 to 60 mph, 200 F oil sump, duplicate tests.

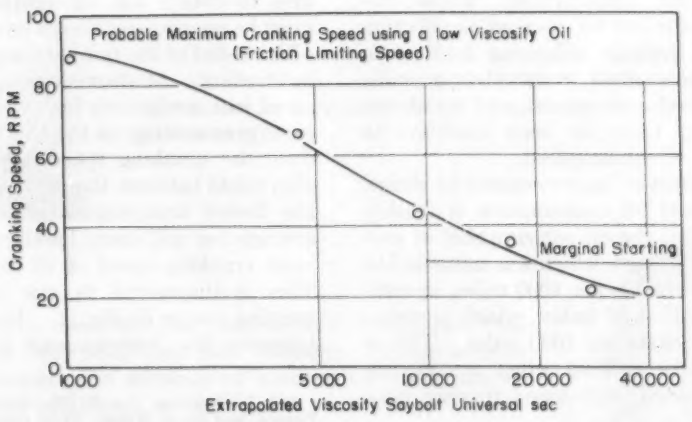

Fig. 4.—Cranking Speed–Oil Viscosity Calibration Curve at −10 F for 6 Cylinder Engine.

100 amp-hr, cold, standard batteries. Data for low pour nonwaxy oils (40 V.I. naphthenic).

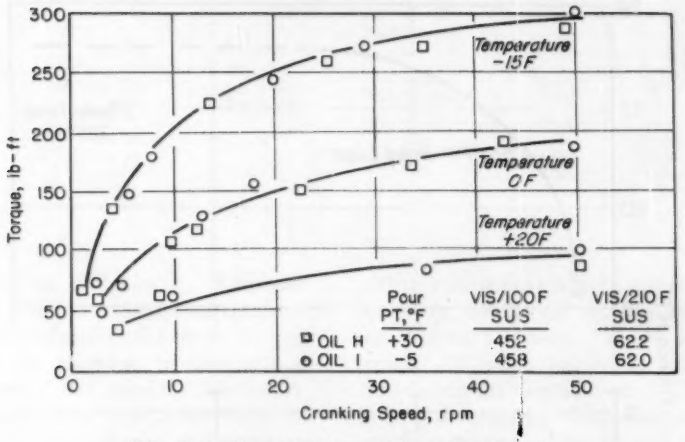

Fig. 5.—Effect of Wax on Cranking Speed.

laboratory engine tests on two similar oils, one formulated with relatively stable V.I. Improver X and the other with relatively unstable V.I. Improver Y. The tests were made under high speed conditions followed by cyclic operation. It will be noted in Figs. 2 and 3 that the oil using the stable V.I. Improver X lost only a small amount of viscosity and V.I. The oil with the unstable V.I. Improver Y lost a larger amount of viscosity and V.I.

The use of a viscosity-unstable V.I. improver has sometimes been justified in the belief that viscosity loss due to V.I. improver degradation is compensated for by viscosity increase due to base stock oxidation. However, V.I. improver breakdown takes place very quickly after the oil is in the engine, whereas oil oxidation takes place relatively slowly. See Fig. 2. Also, most present-day motor oils have very good oxidation stability. Furthermore, some viscosity loss is almost unavoidable in normal automobile operation due to fuel dilution.

Extrapolated versus Actual Low Temperature Viscosity:

The viscosity of the lubricating oil at low temperatures has been shown to be a controlling factor in case of starting. It is not possible, however, to predict cold starting behavior of many lubricating oils from viscosity extrapolations based on 100 and 210 F values. For example, all mineral oils do not follow the ASTM chart[5] linear extrapolation even at temperatures where wax formation is not a factor. Naphthenic oils of relatively low V.I. often give actual low temperature viscosities higher than extrapolated values, while highly refined paraffinic oils often give actual viscosities lower than extrapolated. This is shown in Table III, where ratios for actual to extrapolated viscosities at 0 F range from 1.20 to 0.86 for different oils.

V.I. improved oils also do not always follow the ASTM extrapolation. When these oils deviate it is usually to give low temperature viscosities which are higher than expected. The extent of deviation, if any, depends on the type and amount of V.I. improver used. The significance of this point is illustrated by engine cranking speed tests carried out under carefully standardized conditions. In each case the oil and equipment (including battery) were soaked 30 hr at −10 F. Table IV shows that a V.I. Improver X blend gives cranking speeds slightly better than predicted from extrapolated viscosities. This indicates that the actual viscosity of the oil as the engine is turned over is less than the extrapolated viscosity would indicate. However, the oil made with V.I. Improver Z shows higher viscosities in the engine, based on cranking speeds, than were predicted by the ASTM extrapolation. The crankshaft speed-oil viscosity correlation for this engine was established using a series of nonwaxy naphthenic oils. This correlation is shown in Fig. 4.

Pour Point and Stable Pour Point

In the modern engine lubricant pour point is important in connection with oil pumpability and engine lubrication. If the oil in an engine sump cannot flow to the oil pump inlet, the pump will be starved, the engine will not get proper lubrication, and rapid wear and engine failure can result.

TABLE IV.—COLD STARTING CHARACTERISTICS OF V.I. IMPROVED OILS.
Oils Permit Starting at −10 F, Test Temperature at −10 F.

	Paraffinic Oil + V.I. Improver	
	X	Z
Viscosity index	126	144
Viscosity at 210 F, SUS	52.2	71.6
Cold starting characteristics at test temperature		
Cranking speed, rpm (30 rpm —marginal starting)	32.1	30.3
Viscosity, SUS (ASTM extrapolation)	19 800	14 000
Viscosity, SUS (from cranking speed correlation—Fig. 4)	18 000	19 000

Pour point is defined as the lowest temperature at which oil does not congeal. Pour point is conventionally measured by the ASTM Method of Test for Cloud and Pour Points (D 97-47)[6] which involves chilling the oil at a rapid and relatively constant rate until the oil will no longer flow. However, some oils when exposed to a cold-warm-cold cycle, such as is often encountered under ambient conditions during the winter, will go solid well above the ASTM pour point.[7] This is called pour instability or pour reversion. For example, three oils, D, E, and F, have the same ASTM pour point of −30 F. These oils were stored in bottles placed in open sheds where the temperatures fluctuated from as low as −40 F to above freezing. Each day the bottles were examined to determine whether or not the oil was fluid. Oils E and F were frequently found to be solid at temperatures as high as +5 to +20 F, temperatures well above their ASTM pour point. Oil D remained fluid down to −27 F, and sometimes even below that. Oils E and F are pour unstable, while oil D is pour stable. This is illustrated in Table V. Oils can be tested for pour instability in the laboratory by a test which puts the oil through a typical cold-warm-cold temperature cycle. This is called the S.O.D. Stable Pour Test.[7] It can be seen that a low stable pour point is more important for a motor oil than a low ASTM pour point. There are several pour depressant additives on the market that will impart good pour stability to an oil as well as improve ASTM pour point.

[5] ASTM Standard Viscosity-Temperature Charts for Liquid Petroleum Products (D 341 – 43), 1952 Book of ASTM Standards, Part 5, p. 167, Chart A.

[6] 1952 Book of ASTM Standards, Part 5, p. 51.

[7] J. G. McNab, D. T. Rogers, and A. E. Michaels, "The Pour Point Stability Characteristics of Winter Grade Motor Oils," *Transactions*, Soc. Automotive Engrs., Vol. 2, No. 1, Jan., 1948, pp. 34–44.

TABLE III.—EFFECT OF BASE STOCK TYPE ON LOW TEMPERATURE VISCOSITY CHARACTERISTICS OF STRAIGHT MINERAL OILS.

Base Stock Type	Viscosity, 210 F, SUS	V.I.	Viscosity, 0 F, SUS		
			Actual	Extrapolated	Ratio Actual to Extrapolated
Naphthenic from crude A	38.7	27	7 800	6 000	1.20
Naphthenic from crude B	48.6	43	60 500	57 000	1.06
Extracted naphthenic	44.7	61	21 600	23 000	0.94
Extracted paraffinic	45.7	113	7 300	8 750	0.86

Actually, pour point is not directly related to the ability to start an engine under low temperature conditions. The wax structure which causes an oil to be solid at temperatures below its pour point is easily and quickly destroyed by the shearing forces exerted when an engine is cranked over. Cranking speed is not noticeably diminished by the presence of the wax. This is shown by comparing two oils of the same viscosity, one having a pour of +30 F and the other dewaxed to a pour of −5 F. The torques required to crank an engine at various speeds were the same for both oils at temperatures ranging from +20 to −15 F, as illustrated in Fig. 5.

Effect of Viscosity on Fuel Economy

An important advantage of being able to use light grade oils in modern engines is that they generally permit better fuel economy than is possible with heavier oils. A block mounted six-cylinder engine has been operated under conditions where fuel economy and engine friction could be measured accurately. It has been found, for a series of high V.I. mineral oils, that engine friction is reduced as much as 25 per cent when the oil viscosity is lowered from 71 SUS at 210 F to 44 SUS at 210 F. At the same time fuel economy is increased by 5 per cent. This is shown in Figs. 6 and 7. Other test results available, but not shown, indicate improvement by as much as 10 per cent.

With motor oils containing V.I. improvers, somewhat better fuel economy was obtained than predicted by the viscosity-fuel economy correlation. This is probably due to temporary viscosity loss for the polymer-containing oil at points in the engine where streamline flow occurs. Such viscosity loss is probably the result of a lining up of the polymer molecules under the particular conditions, thus diminishing their thickening effect on blend viscosity.

Temporary viscosity loss of this type shown by oils containing V.I. improvers does not result in higher oil consumption. It will be recalled that in a preceding section it was shown that an oil containing V.I. Improver X was actually slightly lower in consumption than a comparable viscosity straight mineral oil.

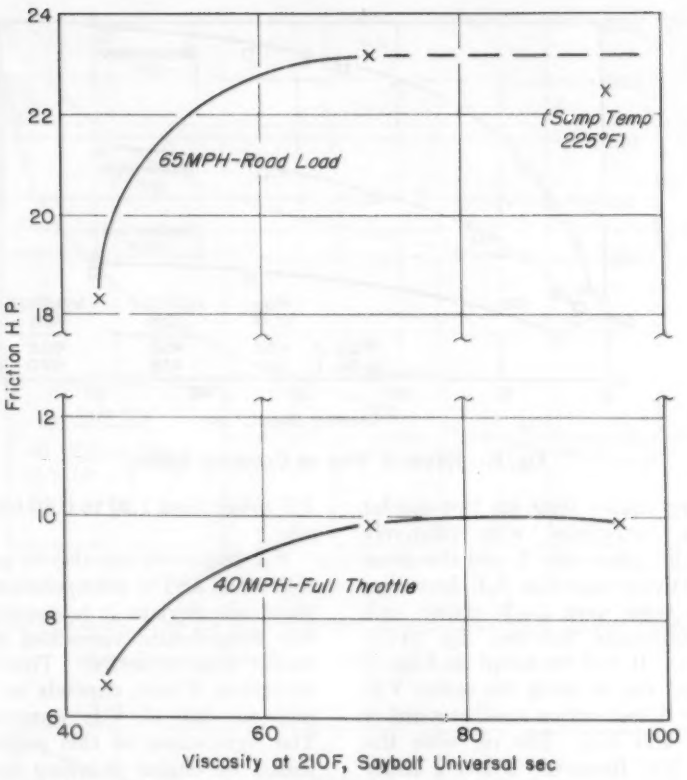

Fig. 6.—Engine Friction *versus* Oil Viscosity.

Block-mounted 6 cylinder engine, 200 F oil sump.

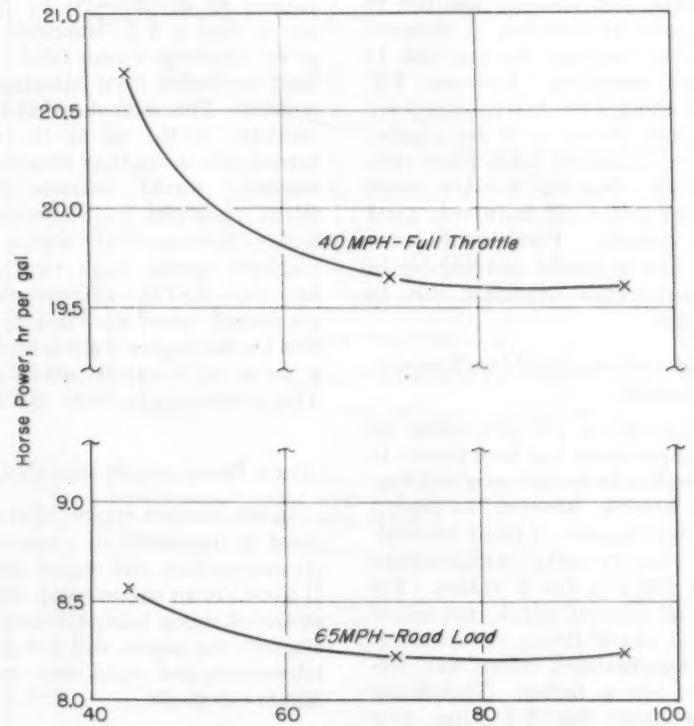

Fig. 7.—Fuel Economy *versus* Oil Viscosity.

Block-mounted 6 cylinder engine, 200 F oil sump.

Engine Cleanliness

Deposit-free operation is important to the optimum functioning of the modern engine. Sludge and varnish deposits can affect two general areas of the engine. One area is that where the lubricant is desired, namely, the crankcase, the bearings, the ring zone, and oil distribution system. Here deposits can be harmful, since they may interfere with the operation of parts having close tolerances, or they may stop the flow of oil in the distribution system. In the other area affected by deposits—the combustion chamber—the presence

TABLE V.—POUR STABILITY OF SAE 10 GRADE LUBRICANTS.

Designation	ASTM Pour Point, deg Fahr	Winter Field Test[a]			Degree of Pour Stability
		Highest Solid Point, deg Fahr	Total Observations	Times Solid	
Oil D	−30	−27	190	1	Excellent
Oil E	−30	+5	190	36	Moderate
Oil F	−30	+20	190	131	Poor

[a] Temperatures from −40 to 60 F.

of lubricant is undesirable. Deposits resulting from the incomplete combustion of the lubricant or for other reasons can cause an increase in the octane requirement of the engine. Of course, fuel residues also can contribute to deposits in the crankcase and combustion chamber.

Crankcase-Lube System Deposits:

Under low temperature operation the deposits formed in the crankcase and other areas where lubricating oil is circulated are usually soft sludges. The formation of this sludge is prone to occur during the low temperature driving because a longer time is required for engine warm-up; and in short trip, stop-and-go driving the engine may never warm up. Under these conditions the fuel does not volatilize properly and combustion is inefficient. Raw gasoline and partially oxidized gasoline products tend to wash other combustion products, such as water, carbon particles and lead salts, into the crankcase where they mix and react to form sludge. Wear which results in high blow-by accentuates this condition. Foreign material entering through the crankcase ventilator or the air intake systems, wear debris, or leaks in the cooling system can also contribute to sludge formation. This sludge can cause trouble by plugging oil screens, sticking rings, blocking the lubricant distribution system, and interfering with the operation of parts having close tolerances. Low temperature sludges can also contribute to piston varnish formation and to oil ring plugging.

Under high temperature operating conditions the combustion process is likely to be more efficient, and combustion products are less likely to enter the crankcase. Those which do enter, in many cases, are evaporated out of the engine. However, the high boiling products and any lubricant oxidation products are concentrated and appear as hard sludge particles or as varnish and lacquer on engine parts. Operation of parts having close tolerances is impaired by varnish formation, and ring zone deposits can lead to maloperation of piston rings.

Lubricant manufacturers have incorporated into their products certain additive materials which, under normal operating conditions, can prevent harmful deposit build-up. These additives include oxidation inhibitors which prevent lubricant degradation. They also include detergent or dispersant additives which prevent fuel resins and soot and other types of insoluble resins from adhering to metal surfaces to build up sludge and varnish. Because numerous data are available in the literature illustrating this point, none will be given here.

Suffice it to say that detergent-inhibitor additives can markedly reduce deposit formation when properly compounded in the finished lubricant. It should be emphasized that even the most highly detergent oil should not be considered a substitute for clean fuels, proper maintenance, and correct engine design.

Combustion Chamber Deposits:

Modern engines having high compression ratios require gasolines of higher octane performance than were necessary when compression ratios were lower. As deposits form in the combustion chamber, the antiknock requirements go even higher so that in some cases existing commercial gasolines no longer satisfy the antiknock requirements.

Even at low levels of oil consumption some oil reaches the combustion chamber and is burned. Any deposit formed in the combustion chamber by the lubricant may contribute to the increase in octane requirement. By the proper choice of lubricants this effect on octane requirement increase can be minimized.

Wear Prevention

One of the obvious functions of a lubricant is to reduce wear, and all lubricants which keep the moving metal parts of an engine separated do this. However, certain lubricants are more effective than others in minimizing wear.

Data obtained by the Esso Laboratories[8] using the radioactive ring technique developed by the Atlantic Refining Co. show that at least in some engines and under certain operating conditions low viscosity oils give substantially less wear than those of higher viscosity. This difference is attributed largely to the ability of the lighter oil to flow more readily into the friction areas. This is particularly important when starting an engine, for only a few strokes of a dry piston ring on a dry cylinder wall can do a lot of surface damage. Data from tests made on a group of four uncompounded mineral oils, varying in viscosity from 36 to 59 SUS at 210 F, are shown in Fig. 8. The mineral oils were from the same general crude source, and all were given the same type of refining.

[8] J. F. Kunc, Jr., and J. P. Hamer, "Lubricants—The Surface Savers," *Transactions*, Soc. Automotive Engrs., Vol. 61, pp. 378-385 (1953).

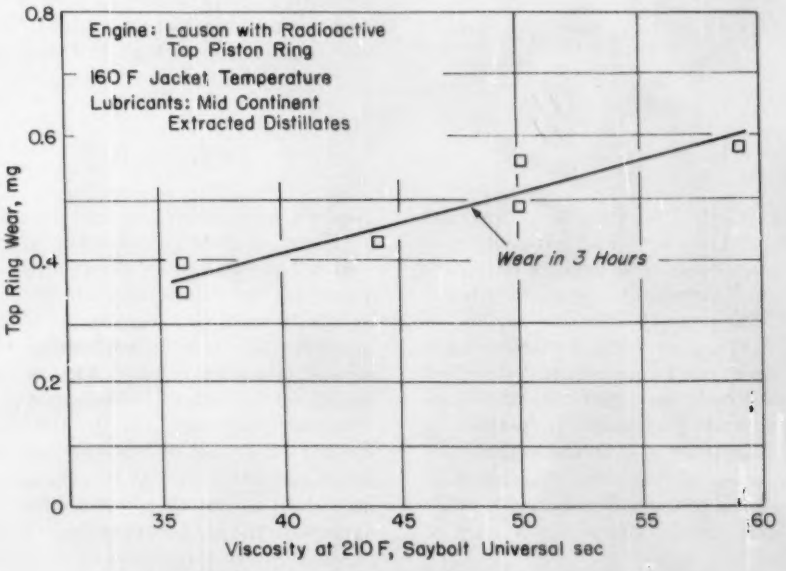

Fig. 8.—Effect of Lubricant Viscosity on Piston Ring Wear.

In these tests, piston ring wear with the oil having a viscosity of 36 sec was less than two thirds of that obtained with the oil of 59 sec viscosity.

The inclusion of detergent-inhibitor type additives in motor oils intended for gasoline engine service has proved beneficial from the standpoint of reducing wear as well as in preventing the accumulation of undesirable ring zone, piston skirt, and sludge deposits. However, the magnitude of the wear reduction obtained through the use of detergent additives in gasoline engine crankcase oils will vary considerably, depending on the type of service to which the oils are subjected. This, in turn, is related to the kind of engines used, the quality of the fuel used, and a host of other factors. An example of the variation in wear improvement, which is obtained through the use of detergent additives, is shown in Table VI. This table presents the results of 12,000-mile tests run on a mineral oil and on the same oil containing a detergent-inhibitor in a fleet of light trucks making house-to-house deliveries. The tests covered roughly a year of operation. When a fuel of relatively poor quality from a sludge and varnish forming standpoint was used, an appreciable reduction in wear was obtained by incorporating a detergent-inhibitor additive in the oil. When a fuel of better cleanliness quality was used, however, wear with the straight mineral oil was very much reduced, and the detergent-inhibitor additive now had a much less significant effect on wear.

TABLE VI.—EFFECT OF DETERGENT ADDITIVES ON GASOLINE ENGINE WEAR.

Light-Duty Truck Fleet—Stop-and-Go Operation.

Detergent-Inhibitor Additive in Base Oil, per cent	Piston Ring Weight Loss in 12,000 Miles, g	
	High Deposit Fuel	Low Deposit Fuel
None	0.81	0.45
4.4	0.56	0.42
16	0.40	...

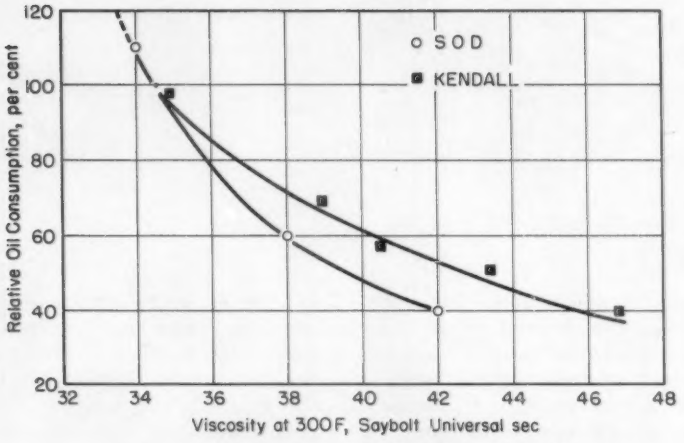

Fig. 9.—Consumption Viscosity Relationship.

Engine parts other than the piston rings are also subject to wear. Because more power is being taken from the modern engine and because these engines are more compact, unit loadings are greater and wear of these parts may become more critical. By incorporation of suitable additives it is possible to build into the lubricant increased film strength and better load-carrying properties. In this way more protection can be given the heavily loaded parts where metal-to-metal contact is most likely to take place.

Conclusion

In conclusion, lubricating oils can be prepared by blending carefully refined base stock with selected additive materials to achieve properties which will satisfy the lubrication requirements of the modern engine. These properties built into the oils include a relatively low viscosity at starting temperatures to provide easy starting and rapid lubrication, a relatively high viscosity at operating temperatures to provide high temperature protection and to control oil consumption, a high viscosity index to provide this combination of properties, low temperature detergency to minimize sludge formation, high temperature oxidation resistance to minimize varnish and lacquer formation, the ability to minimize combustion chamber deposits, and antiwear and film strength properties to prevent corrosive and friction types of wear.

The manufacturers of the automobile engines of today are to be commended for the progress they have made in the design of their product. At the same time the petroleum industry has also made considerable progress in providing lubricating oils to satisfy the requirements of these engines. A mutual understanding of the problems involved in the design and lubrication of the modern engine has provided, and will continue to provide, the automotive and petroleum industries with the means to give the users of their products better and less costly service.

Acknowledgment:

The authors wish to acknowledge the assistance of a number of associates in the Esso Laboratories of the Standard Oil Development Co. in obtaining the data presented in this paper.

DISCUSSION

Mr. F. I. L. Lawrence.[1]—Messrs. Hamer, Tutwiler, and Weisel have presented some new aspects of an old problem, automotive engine lubrication. Their comprehensive review of some of the older subject matter brings together in one paper information which is undoubtedly of interest to the automotive and petroleum industries. I would like to express to the authors our appreciation of their clear description of some of the relationships between lubricant and engine which are a part of modern automotive service conditions.

There are some points in the paper on which I would like to comment; one of these is the relationship between oil volatility and oil consumption. Admittedly this is a difficult relationship to evaluate since in many lines of lubricating oil the volatility decreases as the viscosity increases. With the trend toward the use of lower viscosity crankcase oils, volatility becomes a more important factor than heretofore. We agree with the authors that the volatility of an oil can be minimized by the proper choice of crude type and distillation.

The authors show in Table I of the paper the relationship between viscosity at 300 F and relative oil consumption. No indication of the volatility of these oils is given. We have made some measurements of oil consumption for oils of varying viscosity both in the laboratory and in the field. Some of our work has been concerned with a series of oils blended to vary the viscosity but to maintain substantially constant volatility. This was done by incorporating in each blend the same molecular per cent of the low molecular weight component. This investigation

[1] Kendall Refining Co., Bradford, Pa.

was conducted in a 6 cylinder L-head engine especially equipped with a dry sump crankcase and operated as follows. The engine oil is drained from the crankcase into a reservoir mounted on a scale, readable to 0.01 lb, which is positioned under the engine. The engine oil pump is utilized to circulate the oil in a normal manner.

After a build-up in which new rings and bearings are installed, a break-in run and sufficient reference runs on an oil of known performance are made to insure test operation during a period in which the consumption characteristics of the engine are stabilized.

Operating conditions during test are as follows:

Speed—3150 rpm } approximately 65 mph at road load
Load—30 bhp }
Bulk oil temperature—160 F
Jacket outlet temperature—160 F
Duration of test—6 hr

The test period is started only after temperature and oil flow conditions are stabilized, usually a period of ½ to ¾ hr. The weight of oil retained in the reservoir is read and recorded each hour so that any unusual fluctuations in consumption rate may be noted. The result reported is the average consumption rate over the 6-hr test period.

In using this procedure multiple tests are run on each of several lubricants in a group. These results are then evaluated statistically. The data shown in the accompanying Fig. 9 were obtained in this way. These data were recalculated to allow plotting of a curve having a common reference point with that of the authors. Two of the several possible reasons for difference in the slopes of the curves are oil volatility and differing design of the engines in which the tests were conducted.

In reading the paper presented by the authors, we were unable to understand the reason for the relative oil consumption results reported in Table II. Oil A containing 8 per cent of V.I. improver is shown to have better oil consumption characteristics than an oil of only slightly lower viscosity at 300 F containing bright stock. All of our experience with oils containing V.I. improvers indicates that such oils do not have better oil consumption characteristics than Newtonian oils. We would be interested in any explanation that the authors might be able to give for this result.

MESSRS. J. P. HAMER, T. S. TUTWILER, AND C. A. WEISEL (*authors' closure*).—The authors wish to thank Mr. Lawrence for his comments and his contribution to the oil consumption picture. The effect of volatility of the lubricating oil on oil consumption is recognized, but, as stated in the paper, the proper selection of crude and refining processes eliminates volatility as a significant factor. The relationship between viscosity at 300 F and relative oil consumption shown in Table I of the paper was developed using oils of sufficiently low volatility so that viscosity alone is believed to be controlling. The differences between the consumption data presented by Mr. Lawrence and those in Table I are believed attributable to differences in the test engines and test conditions used. It is interesting to note that the Esso Laboratories and Kendall consumption curves in the region of 38 SUS at 300 F and higher are super-imposable.

No firm explanation is available for the improved oil consumption characteristics noted with the V.I. improved oil in comparison to the oil containing bright stock as shown in Table II. Various hypotheses have been suggested which would explain this behavior on the basis of the effect of rate of shear on oils containing polymeric viscosity index improvers. As yet, however, there has not been an opportunity to substantiate these explanations experimentally.

Subcommittee Report on New Specifications for Bare Stainless Steel Welding Rods and Electrodes

Prepared by Subcommittee IV on High-Alloy Steel Filler Metal of AWS-ASTM Joint Committee on Filler Metal

Two years in the drafting, the new specifications for bare wire filler metals are now available as AWS Specification A 5.9–53 T or ASTM Specification A 371 – 53 T.[1] Prior to its issuance, the Subcommittee prepared the following explanation of the composition requirements in these specifications.

DESPITE the great many advances which have been made in the science of metallurgy and welding in the past decade, Subcommittee IV on High-Alloy Steel Filler Metal of AWS-ASTM Joint Committee on Filler Metal which has been delegated the responsibility for preparing specifications for welding filler metal chemical composition is faced with the problem of setting rather definite limits with fewer quantitative data available than would be desirable. Such a situation results in studied compromises by the subcommittee between the wide limits desired from the standpoint of ease of manufacture to these specifications and the narrow limits desired to make the properties of all materials which meet the specifications as nearly constant as possible.

Since many of the decisions made in this regard are of necessity arbitrary, it was felt desirable to record, for the following reasons, the considerations upon which the chemical composition limits set forth in the specifications are based:

1. To facilitate revision of these specifications when additional data should indicate the desirability of such a revision.
2. To facilitate revision of comparable specifications for covered arc-welding electrodes.
3. To facilitate the acceptance of bare filler metals of modified composition limits where this is necessary in special applications not considered in these specifications.
4. To assist in establishing the risk involved in accepting bare filler metals outside of these specifications.

In the case of the chromium and chromium - nickel corrosion - resistant steels, the sensible point for the development of an electrode specification should be the comparable specifications for base metal of the same grades. Tables I and II provide a comparison between

[1] Tentative Specifications for Corrosion-Resisting Chromium and Chromium-Nickel Steel Welding Rods and Bare Electrodes (A 371–53 T), 1953 Supplement to Book of ASTM Standards, Part 1, p. 295.

TABLE I.—COMPARISON OF BASE METAL AND BARE FILLER METAL CHEMICAL REQUIREMENTS FOR CHROMIUM-NICKEL STEELS, PER CENT.

	Carbon[a]	Chromium	Nickel	Molybdenum	Tin[a]	Manganese[a]	Phosphorus	Sulfur	Nickel Equivalent[b] (Ni)	Chromium Equivalent[c] (Cr)
ER 308	0.08	19.5–22.0[e]	9.0–11.0	...	0.60	1.0–2.5	0.03	0.03	11.0 –14.65	19.95–22.90
AISI 308	0.08	19.0–21.0	10.0–12.0	...	1.00	2.0	0.04	0.03	12.0 –15.40	19.45–22.5
ER 308L	0.03	19.5–22.0[e]	9.0–11.0	...	0.60	1.0–2.5	0.03	0.03	10.1 –13.15	19.95–22.90
AISI 308L	0.03	19.0–21.0	10.0–12.0	...	1.00	2.0	0.04	0.04	11.1 –13.9	19.45–22.5
ER 309	0.12	23.0–25.0	12.0–14.0	...	0.60	1.0–2.5	0.03	0.03	14.0 –18.85	23.45–25.90
AISI 309	0.20	22.0–24.0	12.0–15.0	...	1.00	2.0	0.04	0.03	14.9 –22.0	22.45–25.5
ER 310	0.08–0.15	25.0[b]	20.0[b]	...	0.60	1.0–2.5	0.03	0.03	23.65–27.75	25.45–28.0
AISI 310	0.25	24.0–26.0	19.0–22.0	...	1.50	2.0	0.04	0.03	22.5 –30.5	24.75–28.25
ER 316	0.08	18.0–20.0	12.0–14.0	2.0 –2.5	0.60	1.0–2.5	0.03	0.03	14.0 –17.65	20.45–23.4
AISI 316	0.10	16.0–18.0	10.0–14.0	2.0 –3.0	1.00	2.0	0.04	0.03	12.0 –18.0	18.75–22.5
ER 316L	0.03	18.0–20.0	12.0–14.0	2.0 –2.5	0.60	1.0–2.5	0.03	0.03	13.10–16.15	20.45–23.4
AISI 316L	0.03	16.0–18.0	10.0–14.0	2.0 –3.0	1.00	2.0	0.04	0.03	11.10–15.90	18.75–22.5
ER 317	0.08	18.5–20.5	12.0–14.0	3.25–4.0	0.60	1.0–2.5	0.03	0.03	14.0 –17.65	22.20–25.4
AISI 317	0.10	18.0–20.0	12.0–14.0	3.0 –4.0	1.00	2.0	0.04	0.03	14.0 –18.0	21.75–25.5
ER 330	0.15–0.25	15.0–17.0	34.0[b]	...	0.60	1.0–2.5	0.03	0.03	39.0 –44.75	15.45–17.90
AISI 330	0.25	14.0–17.0	33.0–37.0	...	1.00	2.0	0.04	0.03	36.5 –45.50	14.75–18.50
ER 347	0.08[d]	18.5–21.0[e]	8.5–10.5	...	0.60	1.0–2.5	0.03	0.03	10.5 –14.15	19.20–22.40
AISI 347	0.08[d]	17.0–19.0	9.0–12.0	...	1.00	2.0	0.04	0.03	11.0 –15.40	18.0 –21.0

[a] Denotes maximum permissible values unless range is shown; for computation of equivalents, reasonable values for the minima have been used.
[b] Denotes minimum permissible percentages; for computations of equivalents, a range of approximately 2 per cent has been used.
[c] Computation as indicated by the Schaeffler Diagram (Fig. 1).
[d] Columbium 10 × C minimum, 1.00 per cent maximum.
[e] Chromium: nickel ratio 1.9:1 minimum.

TABLE II.—COMPARISON OF BASE METAL AND BARE FILLER METAL CHEMICAL REQUIREMENTS FOR CHROMIUM STEELS, PER CENT.

	Carbon	Chromium	Nickel (max)	Molybdenum (max)	Manganese (max)	Tin (max)	Sulfur (max)	Phosphorus (max)
ER 410	0.07–0.12	12.0–14.0	0.6	0.6	0.6	0.50	0.03	0.03
AISI 410	0.15 max.	11.5–13.5			1.0	1.0	0.03	0.04
ER 420	0.25–0.40	12.0–14.0	0.6	...	0.6	0.50	0.03	0.03
AISI 420	0.15 min.	12.0–14.0			1.0	1.0	0.03	0.04
ER 430	0.10 max.	15.5–17.0	0.6	...	0.6	0.50	0.03	0.03
AISI 430	0.12 max.	14.0–18.0			1.0	1.0	0.03	0.04
ER 502	0.10 max.	4.5–6.0	0.4	0.45–0.65	0.6	0.60	0.03	0.03
AISI 502	0.10 max.	4.0–6.0			1.0	1.0	0.03	0.04

the AISI specifications and the AWS-ASTM specifications for bare electrodes and welding rods. Since the behavior of materials of the same chemical compositions should be the same in weld deposits as in base metals, the deviation in the chemical composition of the weld deposits must be explained on the basis of changes in compositions in the transfer of metal to the weld or in other special considerations required in welding to achieve a sound weld or a weld of satisfactory properties in view of the micro segregation and cast structure present in the weld deposit.

In order to simplify the presentation, the deviations in chemical compositions of the chromium-nickel and chromium grades will be discussed separately

Chromium-Nickel Stainless Steels

The earliest attempts to weld with filler metals of compositions similar to the chromium-nickel austenitic steel base metals resulted either in micro or macro cracking. On an almost empirical basis, it was found that those compositions with lower nickel contents and higher chromium contents exhibited much less tendency toward cracking than the normal compositions. Micro examination of weld deposits of the crack-free welds showed them to contain small percentages of a second constituent, ferrite, in the austenitic matrix.

The metallurgical phenomenon involved in the formation of the duplex ferrite-austenite structure of these welds is quite involved but it is of sufficient importance to warrant a brief discussion. Pure iron solidifies first as δ-ferrite and upon cooling transforms to austenite; at lower temperatures the austenite transforms to α-ferrite, the phase stable at room temperature. Additions of nickel, carbon, and manganese to iron tend to suppress the lower temperature transformation from austenite, and when the percentages of these elements are sufficiently high the transformation may be suppressed to subzero temperatures, producing an austenitic steel. The addition of chromium, molybdenum, silicon, titanium, columbium, and tungsten to iron tends to suppress the high-temperature transformation of ferrite to austenite and, when sufficient percentages of these elements are present, the transformation may be completely suppressed, producing a ferritic steel. Thus a proper balance of nickel, carbon, and manganese with chromium, molybdenum, silicon, titanium, columbium, and tungsten may produce a weld deposit that may consist of either austenite or ferrite or a mixture of the two phases in any proportion.

The quantitative effect of these elements in this regard is well shown in the Schaeffler diagram presented in Fig. 1. The approximate structure of a weld metal composition may be determined by locating the composition on the diagram after multiplying the percentages of the elements by the proper factor.

The chemical compositions limited by the AWS-ASTM bare electrode and welding rod specification are shown in Figs. 2, 3, 4, 5, 6, and 7, together with the comparable base metal specifications. When welding AISI steels with similar filler metals, the resulting weld metal composition and hence its microstructure is influenced by the base metal composition as well as the filler metal composition. Any changes in composition which take place during fusion, especially those encountered in submerged arc welding, must also be considered in using the diagrams to predict approximate weld compositions and microstructures.

It will be observed that the base metals for the most part tend to fall more in the austenitic region, whereas the weld metal compositions meeting ER 308, ER 308L, and ER 347 must contain some ferrite. This has been

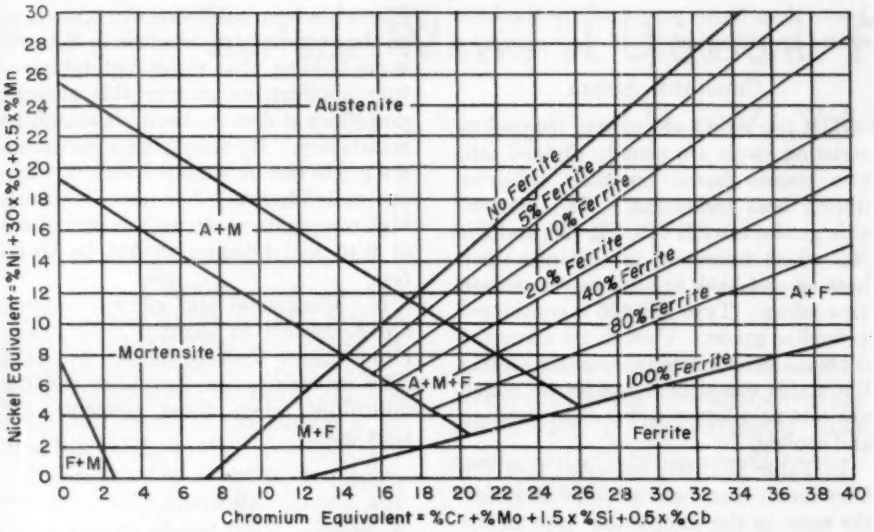

Fig. 1.—Schaeffler Constitution Diagram for Stainless Steel Weld Metal.

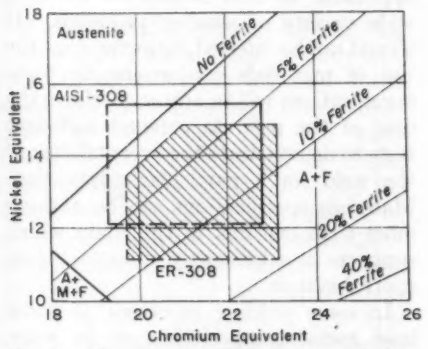

Fig. 2.—Constitution Diagram for ER 308 Stainless Steel Weld Metal.

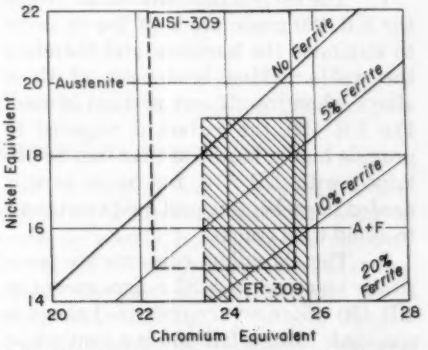

Fig. 3.—Constitution Diagram for ER 309 Stainless Steel Weld Metal.

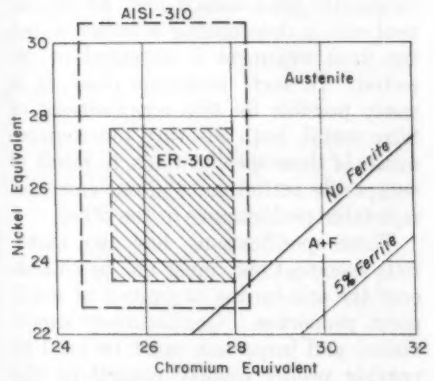

Fig. 4.—Constitution Diagram for ER 310 Stainless Steel Weld Metal.

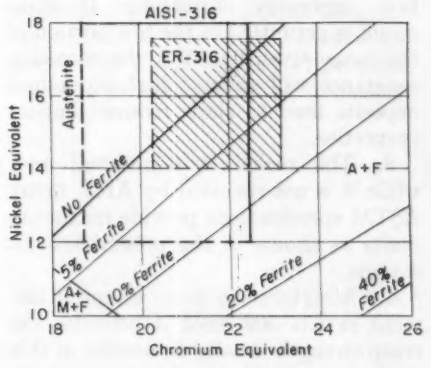

Fig. 5.—Constitution Diagram for ER 316 Stainless Steel Weld Metal.

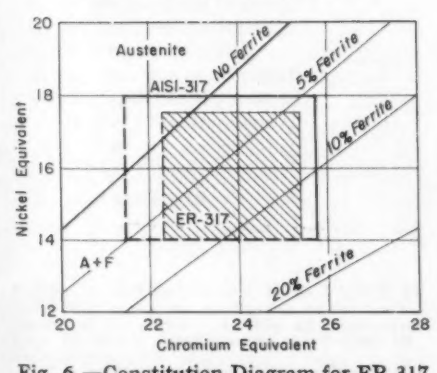

Fig. 6.—Constitution Diagram for ER 317 Stainless Steel Weld Metal.

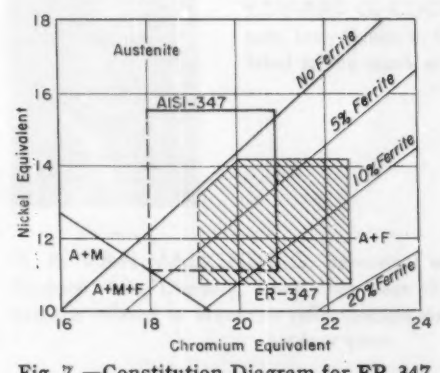

Fig. 7.—Constitution Diagram for ER 347 Stainless Steel Weld Metal.

accomplished by requiring higher chromium and lower nickel contents. No figures have been included for the ER 308L and ER 316L compositions because, as can be seen in Table I, the chromium equivalents are identical with the ER 308 and ER 316 compositions, and nickel equivalents are only slightly lower as a result of the lower carbon maximum. Additional assurance of the presence of ferrite is obtained by limiting the Cr:Ni ratio to 1.9:1 minimum which in effect cuts off the upper left-hand corner of the diagram.

The lower limits on nickel and the upper limits on chromium are restricted in order to control the maximum ferrite present in the weld deposit. Increased percentages of ferrite in the weld deposit may be expected to have the following effects:

1. Since ferrite is magnetic the permeability of the weld deposit will increase.

2. The ferrite phase has a tendency to transfrom to the brittle sigma phase during heat treatment in the range of 1300 to 1600 F or during service at temperatures above 1000 F, with a resultant loss in ductility. Some experience has been reported with embrittlement in highly ferritic weld deposits at temperatures as low as 800 F, similar to the embrittlement in the straight chromium steels in this range. The embrittlement resulting from both these phenomena increases with increasing percentages of ferrite.

3. Since the corrosion resistance of the chromium-nickel austenitic steels is due to the formation of a continuous adherent chromium oxide film on the surface and is not greatly dependent upon the steel being austenitic, the presence of ferrite does not adversely affect the corrosion resistance as measured by the Strauss and Huey tests. One case has been encountered, however, where pitting of the ferrite has occurred in a mildly corroding medium.

For the above reasons the committee endeavored to limit the ferrite content to a maximum value by the control of chemical composition within commercially acceptable limits.

In the molybdenum-containing alloys ER 316, ER 316L, and ER 317, the specifications permit both fully austenitic and partially ferritic weld deposits. While this is in contradiction to the thesis that the presence of ferrite is important in preventing weld cracking, it has been observed that the presence of molybdenum tended to inhibit cracking even in the fully austenitic compositions of these electrodes.

It may be noted in Fig. 4 that the ER 310 compositions have structures consisting only of austenite. This is

also true of ER 330 compositions. It is obvious from Fig. 4 that prohibitive alterations in composition would be necessary to provide partially ferritic welds, and, as might be expected, welds of these compositions are more prone to cracking than the electrodes discussed previously.

Experience with welds of the fully austenitic type have indicated that it is desirable to maintain a high manganese content and a low silicon content and that a low ratio of silicon content to carbon content is desirable. While the reasons for the effectiveness of a high manganese content in preventing cracking are not fully understood, it may be postulated that its effectiveness is due to the elimination of grain boundary sulfide films. It has been proposed that low silicon contents and a low silicon to carbon ratio prevent the formation of low melting silicate films which may also form in grain boundaries and cause cracking.

In accordance with the above, the carbon contents of ER 310 and ER 330 are higher than permitted in the other electrode specifications. It may be noted that a uniformly higher manganese content and a lower silicon content are required for all the chromium-nickel electrodes than for comparable base metal specifications. This results from the desire to minimize cracking in the partially ferritic grades as well as in ER 310 and ER 330 in the event that base metal dilution causes sufficient composition change to make the structure of the normally partially ferritic grades fully austenitic.

While it would also be desirable from the standpoint of weld cracking to permit higher carbon contents in the ER 308, ER 309, ER 316, ER 317, and ER 347 grades, higher carbon contents would result in a lower corrosion resistance because of the localized depletion of chromium caused by the precipitation of chromium carbides. Because of the above consideration, the carbon contents of ER 316 and ER 317 are lower than those permitted by the base metal specification.

Chromium Steels

The straight chromium corrosion-resisting steels are usually divided into two classes based on their behavior during heat treatment. The martensitic grades are ER 410, ER 420, and ER 502 which transform to austenite upon heating and back to hard martensite on air cooling. Type ER 430 is considered a ferritic grade. Though its structure contains some martensite, on air cooling the major constituent is δ-ferrite which exhibits no allotropic change on heating and cooling.

In Table II it will be noted that the filler metal compositions are essentially the same as the comparable base metals with a few exceptions:

1. The carbon contents for all except the ER 420 grade are kept low in order to minimize the hardness and therefore the weld-cracking tendencies of these alloys when insufficient preheat is used. For ER 420, the carbon is required to provide higher hardness than can be obtained with ER 410, but more care is needed in preheating and heat treatment to avoid weld cracks.

2. The chromium contents are practically identical to AISI ranges except in ER 430 where a very restricted range is specified. Since ER 430 is a borderline alloy, its corrosion and impact properties are sensitive to change in composition, especially chromium. If chromium is permitted in the low portion of the range given by AISI, the corrosion resistance will suffer; high chromium deposits tend to show reduced impact properties.

3. The nickel is a residual and, while it is not specified by AISI, many ASTM specifications provide maximum limits as shown in the present specifications.

4. Molybdenum is an essential element in ER 502 since it provides the creep strength usually demanded of this grade in service and minimizes embrittlement at elevated temperatures. There has been a difference in opinion as to the need for molybdenum in ER 410, some holding that some high-temperature applications require this element and, since it does no harm, it should be mandatory. By specifying a maximum the grade can be supplied with or without molybdenum. For users requiring high-temperature strength a minimum of 0.40 molybdenum should be specified.

5. Manganese and silicon contents are controlled to slightly lower maximum values than permitted by AISI since experience has shown less welding difficulties when these elements are kept low.

General

These specifications are considered applicable to filler metals for use in a wide variety of welding processes. It should not be inferred, however, that the use of materials conforming to these specifications will in any way relieve the user of the need to conduct sufficient tests to demonstrate the acceptability of the weld for a particular application. Materials specifications can be nothing more than one link in the chain which supports a satisfactory manufacturing control system.

In some welding processes, in some base metal compositions, or in some ranges of base metal size or thickness, borderline conditions may prevail, and frequently filler metals play an important role in determining whether or not the final weldment is accepted or rejected. In such borderline cases, it is easily possible for two compositions of filler metal, both meeting the requirements of these specifications, to result in acceptable performance in one case and rejectable performance in the other.

These specifications, like any materials specifications, must not be considered the sole means of control of weldment properties. Qualification, supervision, and inspection must be used to provide proper quality control of the product.

Surface Waves at Ultrasonic Frequencies

By E. G. Cook and H. E. VanValkenburg

The authors review the theory of mechanical wave propagation along the surface of an extended solid medium adapting it to non-destructive materials testing.

AMONG the several types of elastic waves (1)[1] that may be generated in solids are surface waves. A surface wave is defined as an elastic vibration whose energy is confined to a narrow region just below the free surface of an extended solid, having a velocity of propagation independent of frequency, depending only upon the density and elastic moduli of the solid. Waves of this type are also called Rayleigh waves (2).

Experimental techniques for studying surface waves were almost entirely confined to seismological (3) and shock wave (4) experiments until the development of electronics. In the early 1940's, F. A. Firestone (5) developed electronic equipment, known as the Reflectoscope, to generate and analyze by pulse techniques various types of elastic waves including surface waves. Recent advancements (6) of the Reflectoscope technique have produced a new type search unit for generating and detecting surface waves. These search units greatly facilitate the experimental investigation of surface waves under a wide variety of conditions and extend their application to routine industrial inspection problems.

Theory of Surface Waves

Particle Displacement:

In developing the theory of surface waves, it is assumed that the solid is perfectly elastic, homogeneous, and isotropic. Further, it is assumed that the elastic strains involved produce very small deformations. This is a reasonable assumption at ultrasonic frequencies.

While solving the appropriate elastic equations (7) for wave motion along the free surface of a solid, it becomes apparent that if the velocity of propagation is to be independent of frequency, the dimension of the solid perpendicular to the surface must be large compared to a wavelength. The equations show that these waves travel without attenuation in the direction of propagation, but that their energy decreases rapidly as the wave penetrates below the surface. The particle displacement of the wave motion follows an elliptical orbit where the major axis of the ellipse is perpendicular to the surface and where the minor axis is parallel to the direction of propagation. The magnitudes of these axes are given by the expressions of Eq. 1 where u represents the minor axis (longitudinal) displacement and v represents the major axis (transverse) displacement:

Since steady-state conditions were assumed to be established, it is necessary to introduce the parameter K whose value will be dependent upon the initial boundary conditions.

Velocity Ratios:

The velocity ratios contained in Eqs 1 can be expressed as a function of Poisson's ratio (7,8). This relationship is given in Eq. 2:

$$u = K\left[\frac{2\left(1-\frac{v_r^2}{v_L^2}\right)^{1/2}\left(1-\frac{v_r^2}{v_t^2}\right)^{1/2}}{2-\frac{v_r^2}{v_t^2}} e^{-\frac{2\pi}{\lambda}\left(1-\frac{v_r^2}{v_t^2}\right)^{1/2} y} - e^{-\frac{2\pi}{\lambda}\left(1-\frac{v_r^2}{v_L^2}\right)^{1/2} y}\right]\sin(\omega t + kx)$$

$$v = -K\left[\frac{2\left(1-\frac{v_r^2}{v_L^2}\right)^{1/2}}{2-\frac{v_r^2}{v_t^2}} e^{-\frac{2\pi}{\lambda}\left(1-\frac{v_r^2}{v_t^2}\right)^{1/2} y} - \left(1-\frac{v_r^2}{v_L^2}\right)^{1/2} e^{-\frac{2\pi}{\lambda}\left(1-\frac{v_r^2}{v_L^2}\right)^{1/2} y}\right]\cos(\omega t + kx) \quad \text{.....(1)}$$

where:

v_L = longitudinal velocity,
v_t = transverse velocity,
v_r = surface velocity,
x = direction of propagation,
y = depth below surface,
ω = $2\pi f$ (f = frequency),
k = $\frac{2\pi}{\lambda}$, and
λ = wavelength.

EDWARD G. COOK, Engineering Research Section, Sperry Products, Inc., Danbury, Conn., is concerned with acoustic problems related to the application of ultrasonic techniques to the nondestructive testing of materials.

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NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

$$\left(\frac{v_r}{v_t}\right)^6 - 8\left(\frac{v_r}{v_t}\right)^4 + 8\left(3 - \frac{1-2\sigma}{1-\sigma}\right)\left(\frac{v_r}{v_t}\right)^2 - 16\left[1 - \frac{1-2\sigma}{2(1-\sigma)}\right] = 0 \quad \ldots\ldots(2)$$

where σ = Poisson's ratio.

The ratio of the surface velocity to the longitudinal velocity can be related to Poisson's ratio by substituting the following expression for v_t in Eq 2:

$$v_t = v_L \sqrt{\frac{1-2\sigma}{2(1-\sigma)}} \quad \ldots\ldots(3)$$

The curves of Figs. 1 and 2 graphically relate the velocity ratios to Poisson's ratio. The ratios of surface to transverse velocity were computed as shown in Table I to three significant figures by inserting each 0.010 increment of Poisson's ratio into Eq 2. The ratios of surface to longitudinal velocity were computed from Fig. 1 and Eq 3.

A useful approximation for Eq 2 has been given by Bergmann (9):

$$\frac{v_r}{v_t} = \frac{0.87 + 1.12\sigma}{1 + \sigma} \quad \ldots\ldots(4)$$

Equation 4 gives values for the surface velocity that are in close agreement with the values taken from the graph of Fig. 1.

From the graphs of Figs. 1 and 2 the value of the displacement functions can be computed for various Poisson's ratios. The results of these calculations can be illustrated by the diagrams of Fig. 3. This type of representation has been used by Firestone. The solid line represents the surface of the material. The dashed lines represent various depths below the surface. The orbits for four different values of Poisson's ratio are drawn on the same figure. All of the magnitudes of the displacements are referred to the value of the transverse component v at the surface of the solid.

TABLE I.—SOLUTION OF SURFACE WAVE EQ 2.

Computed Values for Fig. 1.

Poisson's Ratio	v_r/v_t	Poisson's Ratio	v_r/v_t
0.000	0.874	0.260	0.921
0.010	0.875	0.270	0.923
0.020	0.878	0.280	0.924
0.030	0.880	0.290	0.926
0.040	0.882	0.300	0.927
0.050	0.884	0.310	0.929
0.060	0.886	0.320	0.930
0.070	0.887	0.330	0.932
0.080	0.889	0.340	0.934
0.090	0.891	0.350	0.935
0.100	0.893	0.360	0.936
0.110	0.895	0.370	0.938
0.120	0.897	0.380	0.939
0.130	0.899	0.390	0.941
0.140	0.900	0.400	0.942
0.150	0.902	0.410	0.944
0.160	0.904	0.420	0.945
0.170	0.906	0.430	0.946
0.180	0.908	0.440	0.948
0.190	0.909	0.450	0.949
0.200	0.911	0.460	0.950
0.210	0.913	0.470	0.952
0.220	0.914	0.480	0.953
0.230	0.916	0.490	0.954
0.240	0.918	0.500	0.955
0.250	0.919		

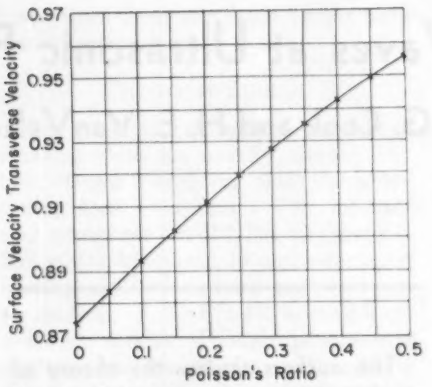

Fig. 1.—Ratio of Surface to Transverse Velocity *versus* Poisson's Ratio. Velocity ratios computed from Eq 2.

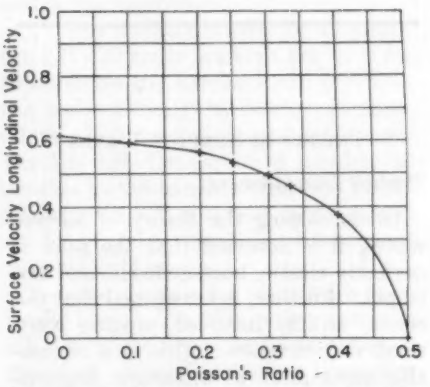

Fig. 2.—Ratio of Surface Longitudinal Velocity *versus* Poisson's Ratio. Velocity ratios computed from Eq 3 and Fig. 1.

Energy:

The elastic strains involved in the wave motion may be computed by a partial differentiation with respect to direction of the displacement functions given by Eq 1. The elastic stresses can be obtained from the strains by applying Hooke's law. The values of the amplitudes of the stress components for steel have been calculated and are plotted as a function of distance below the surface in a recent monograph (10) by H. Kolsky. The particle velocities may be obtained by a partial differentiation, with respect to time, of the displacement functions.

The total energy of the wave motion at a given depth is equal to the sum of the potential and kinetic energies. The potential and kinetic energies can be divided into components parallel to the major and minor axes of the ellipse. It can be assumed that for a given axis and a given depth the sum of the components of the kinetic and potential energies will be a constant with respect to time; further, when the kinetic energy becomes a maximum, the potential energy will become zero. Therefore, the total energy can be expressed as the sum of the two maximum components, parallel to the axes, of the kinetic energy. Since the maximum value of kinetic energy is proportional to the maximum value of the particle velocity, the total energy at a given depth relative to the energy at the surface may be expressed as the sum of the squares of the displacement functions given by Eq 1.

Experimental Studies

Methods of Generation:

Firestone proposed the use of a Y-cut quartz crystal to generate surface waves. The width of his crystal had to be about seven times its thickness. This type of crystal is satisfactory for laboratory measurements but it is not practical for industrial applications.

Another method of generating surface waves is to place an X-cut quartz crystal against the sharp corner of a plate so that the face of the crystal makes an angle of about 45 deg with the surface of the plate. But the energy of these waves is relatively small when compared to other methods.

The construction and performance of the new crystal search unit make it readily adaptable to both industrial and laboratory applications. This search unit generates surface waves by means of refraction. An X-cut crystal is placed against the surface of a wedge as shown in Fig. 4. The wedge angle ϕ_1 is chosen so that the refracted angle ϕ_2 is 90 deg. The proper wedge angle can be obtained from Snell's law:

$$\sin \phi_1 = \frac{v_1}{v_2} \quad \ldots\ldots(5)$$

where v_1 = velocity in plastic wedge and v_2 = surface velocity.

When the proper angle is obtained, a relatively high-energy surface wave will be propagated along the surface of the solid in the forward direction only.

In all three of these methods the piezoelectric crystals were excited and the resulting surface wave detected and analyzed by pulse techniques.

Velocity Measurements:

An attempt was made to verify experimentally the computed curves of Figs. 1 and 2. To accomplish this the longitudinal and surface velocities of three materials were experimentally determined. Then the velocity ratios were taken and the value of Poisson's ratio for each material was determined from Fig. 2.

The materials used were steel, aluminum, and titanium carbide. The measurements were made by employing

TABLE II —VELOCITY MEASUREMENTS.[a]

Material	v_L, cm per sec	v_T, cm per sec	v_T/v_L	Poisson's Ratio[b]
Steel, cold rolled	5.90×10^5	3.00×10^5	0.509	0.28
Aluminum, 24ST	6.37	2.95	0.463	0.34
Titanium carbide, sintered	8.22	4.51	0.549	0.22

[a] Based on longitudinal velocity in steel of 5.90×10^5 cm per sec.
[b] Poisson's ratio obtained from Fig. 2.

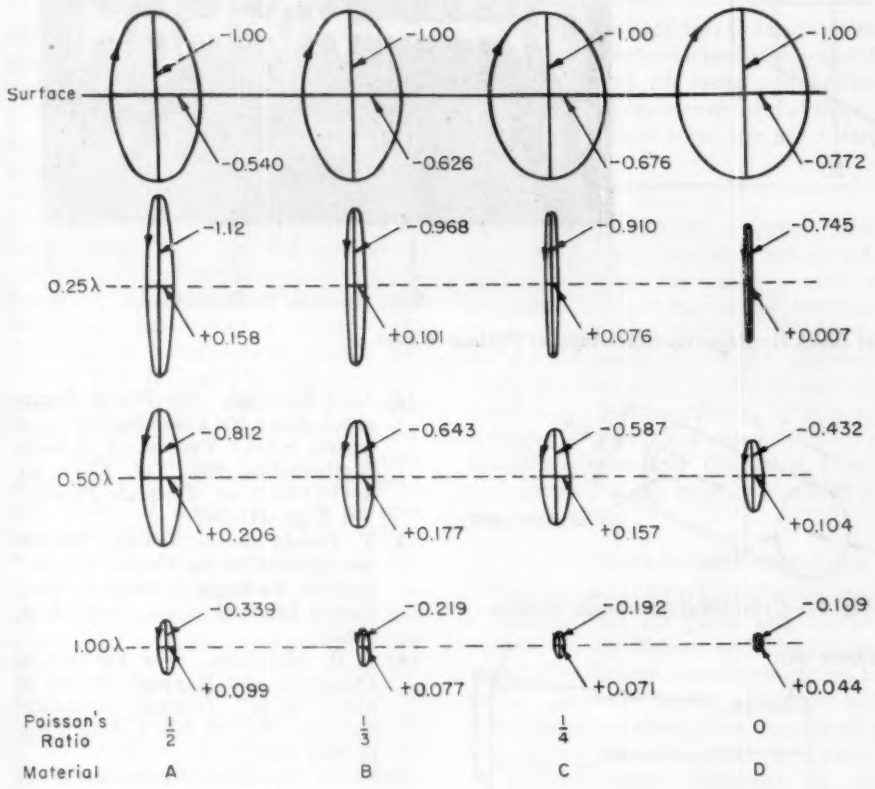

Fig. 3.—Particle Orbits in a Surface Wave.

the Reflectoscope. Table II lists the results of these measurements. Reasonable values for Poisson's ratio were obtained.

During the course of these velocity measurements, it became apparent that if the thickness of the material was decreased until it approached a wavelength, data interpretation would become difficult due to Lamb (11,12) waves.

Energy Measurements:

An experimental study of how the energy of the surface wave decreases as a function of distance below the surface of an aluminum block was carried out with one of the new 2.25-mc, wedge-type search units. The test block is shown in Fig. 5. The aluminum test block has seven 0.018-in. diameter holes drilled $\frac{1}{4}$ in. into its side. The holes are drilled in seven steps below the surface ranging from 0.019 to 0.089 in. The signals shown in the Reflectogram are produced by the reflection of the surface waves from the sides of the test holes. An estimate of the relative energy of the surface wave at various depths below the surface can be obtained from the amplitudes of these reflections.

A series of Reflectograms similar to the one shown in Fig. 5 was taken. An indication of the energy of the surface wave at four different depths was obtained from this series of Reflectograms by squaring the average values of the measured amplitudes. These values are plotted on the graph of Fig. 6. It was impossible, due to practical limitations, to obtain experimental data closer to the surface than about 0.38 wavelengths. The theoretical curve was obtained by taking the sum of the squares of the amplitude terms given by Eqs 1. Poisson's ratio for aluminum was assumed to be equal to $\frac{1}{3}$. These theoretical points are good only to slide rule accuracy. The experimental and theoretical curves were normalized at 0.38 wavelengths below the surface.

Applications:

The new wedge type search unit has made it possible to generate surface waves on many sizes and shapes of solids. Included among these solids are samples of steel, aluminum, beryllium, magnesium, and titanium. Tests on these samples indicate that surface waves will travel with practically no attenuation along many feet of a solid if the surface of the solid is very smooth. Any scratch or defect in or just below the surface will cause an acoustic reflection. This reflection can be detected by the Reflectoscope and will appear as a signal similar to those shown in the Reflectogram of Fig. 5. The approximate size and location of the defect can be determined from the Reflectogram.

Surface waves can be generated on curved as well as on flat surfaces. Some examples are shown in Figs. 7 through 9. Signals from reflected surface waves were obtained from corners *a* and *b* of the steel block shown in Fig. 7. It is interesting to note that surface waves will propagate around corners if the corners are not too sharp.

Figures 8 and 9 illustrate how the new search unit makes it possible to propagate surface waves on complex surfaces. In Fig. 8 surface waves were generated on the curved aluminum surface. The waves were found to travel over edge *a* and continue down the flat surface to edge *b*. Strong reflections were obtained from both edges *a* and *b*. The surface waves traveled "up and over" the fillets on the 6-ft axle shown

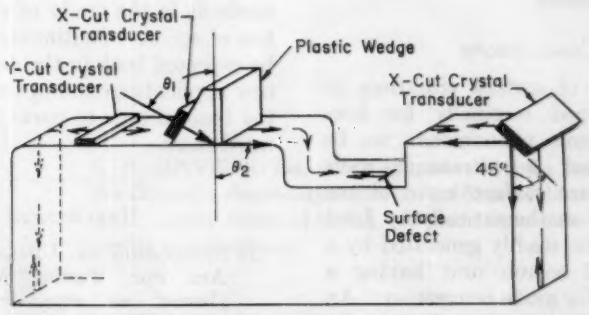

Fig. 4.—Methods of Generation of Surface Waves.

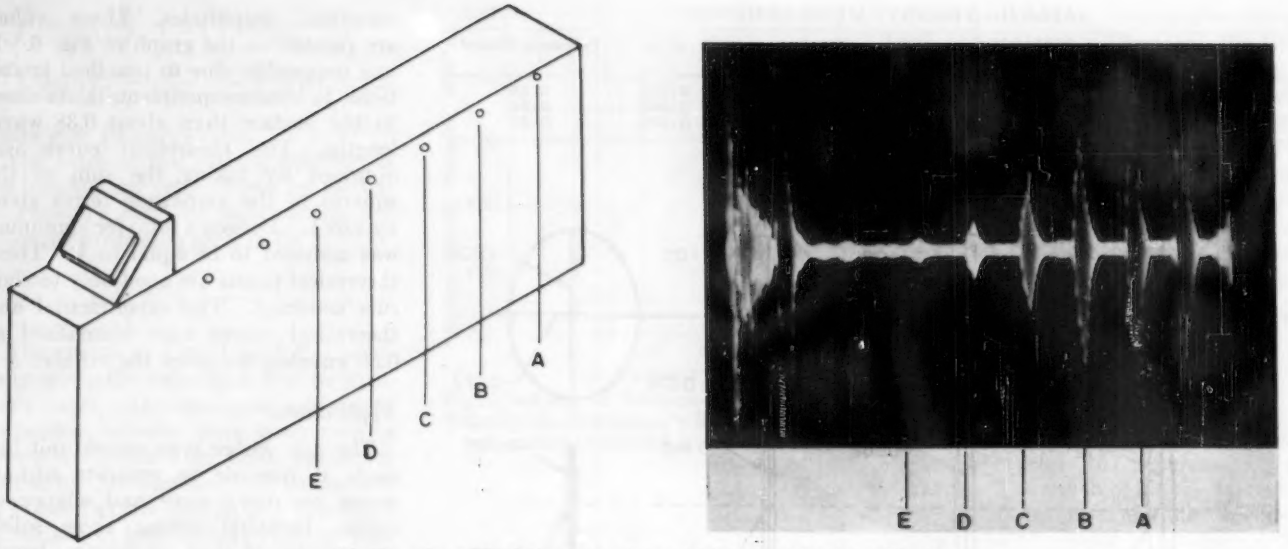

Fig. 5.—Test Block for Experimental Study of Surface Waves.

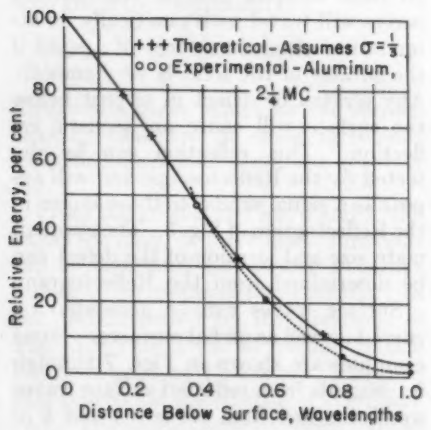

Fig. 6.—Energy of Surface Wave (Per Cent) *versus* Distance Below Surface (Wave Lengths).

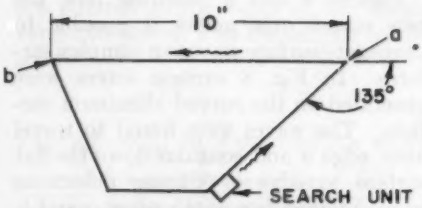

Fig. 7.—Polished Steel Surface.

in Fig. 9. They were reflected from interface *a* and returned to their point of origin.

Conclusions

The theory of surface vibrations in solids, developed originally for low-frequency seismic phenomena, can be usefully applied to ultrasonic wave studies. A pure surface wave of the type described mathematically by Lord Rayleigh can be readily generated by a quartz crystal search unit having a plastic wedge for mode conversion. An ultrasonic Reflectoscope utilizing the principle of pulsed wave trains is a suitable instrument for generation and detection of the required electrical signals. Experimental results obtained with such equipment indicate that wave velocity and attenuation with depth agree with theory, even though the latter is based on continuous wave analysis.

The surface wave technique extends the application of ultrasonic inspection into new fields, particularly in the detection of flaws at the surface or hidden just under the surface.

It is a valuable adjunct to established methods in the study of elastic properties of solids. Continuing progress can be expected both in the development of new applications and in the extension of the basic theory to cover more complicated cases.

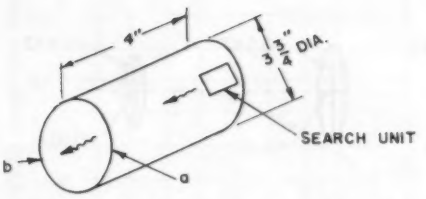

Fig. 8.—Cylindrical Aluminum Surface.

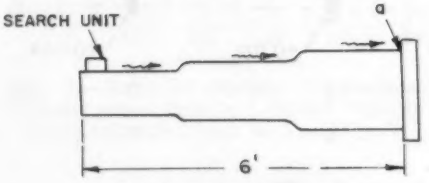

Fig. 9.—Axle Surface.

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Impact Tester for Textiles

By J. B. Dickson and L. A. Davieau

A versatile impact tester for textiles adapted to determining the impact tensile strength of yarns and fabric strips or tear resistance of fabrics—in successful use over the past ten years.

For many textile applications, impact or dynamic tear resistance is the most important functional property.[1] Impact tensile strength[1] is another such property. In service, tear usually occurs under dynamic conditions—that is, failure is a rip, unlike the tearing that results from the slow movement of the jaws of a testing machine employed for the commonly used tear tests. An impact tear test, therefore, simulates conditions in service better than does a static test. The impact textile tester herein described was devised with the object of providing a single tester which, with suitable accessories, could be used for the determination of impact tensile strength of strands (yarns, cord, etc.) and strips of fabric, as well as tear resistance of fabrics.

Practical laboratory testing, as distinguished from research testing, requires an instrument which provides technically acceptable accuracy at low testing cost. Furthermore, since impact strength varies considerably from that of a strand of yarn to that of a strip of heavy fabric, a broad range of capacities is necessary if one tester is to provide adequate precision for all. A tester meeting these requirements is unusually versatile, a circumstance which should encourage the practice of determining impact strength, which has heretofore been neglected.

The instrument devised is, in principle, an ordinary pendulum impact tester such as is employed for metals, plastics, etc. In testing yarns, cords, and strips of fabric, one end of the strand is clamped in a jaw in the bob of the pendulum, and the other end is clamped between fixed jaws. The length of the strand and the position of the fixed clamp are so selected that at the low point of the swing the strand is taut and at the release point slack. The break occurs near the bottom of the swing, the point of maximum velocity.

For conducting a tear test, the simplest method is to cut a strip of fabric with two long tabs, stopping the center cut short of the end in order to leave the desired length of tear. However, the sample of fabric available is not always sufficiently large for cutting such a specimen, nor is it easy to die one out; hence it has been found expedient to use a short specimen. In this case one tab is clamped in the pendulum and the other is in effect lengthened by tape or webbing, one end of which is fixed in a stationary post and the other (free) end carries a clamp which is attached to the second tab.

Previous Instruments

As long ago as 1910 Lester[2] developed a ballistic test for yarns and fabrics, referred to by Turner and Venkataraman,[3] who further provide references to other previous work; Turner and Venkataraman themselves employed a Goodbrand ballistic tester for yarns. A ballistic tester orginated by the Shirley Institute, England, is described in British Standards Handbook No. 11, "Method of Test for Textiles." This tester has a supplementary specimen pendulum mounted on the same axis as the weight pendulum. With the specimen pendulum vertical, one tab of a short specimen is clamped in the pendulum and the other tab is clamped to a fixed post. When the weight pendulum is dropped, it picks up the specimen pendulum, tearing the specimen. The energy absorbed is read as usual from the position of a pointer on a graduated arc. In such tests, specimens cut to give 1- and 4-in. lengths of tear are employed, the difference between the two giving the energy required to tear 3 in. The results are converted into force units.

The Elmendorf tear tester, originally devised for paper testing, is in use in this country. It employs a pendulum and has many of the advantages of the tester herein described, but it is not strictly an impact tester. The tear starts when the pendulum is released—that is, at zero velocity instead of at the maximum velocity. The results are reported in force units. The instrument is not adapted to other than tear testing.

Lang[4] describes a ballistic tester adapted to short samples. In this instrument one clamp is on the end of a

[2] J. H. Lester, *Journal*, Textile Inst., Vol. 1, pp. 63, 73 (1910).

[3] A. James Turner and V. Venkataraman, "A Study of Comparative Results for Lea, Single Thread, and Ballistic Tests on Yarns from Standard Indian Cottons," *Journal*, Textile Inst., Vol. 22, No. 4, April, 1931, p. T197.

[4] W. R. Lang, "Ballistic Determination of Work of Rupture of Short Textile Samples," *Journal*, Textile Inst., Vol. 42, No. 7-8, July-August, 1951, p. T314.

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NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] For examples, see John B. Dickson, "Functional Properties in Textile Design," *Journal*, Textile Inst., Vol. 44, No. 8, August, 1953, P514.

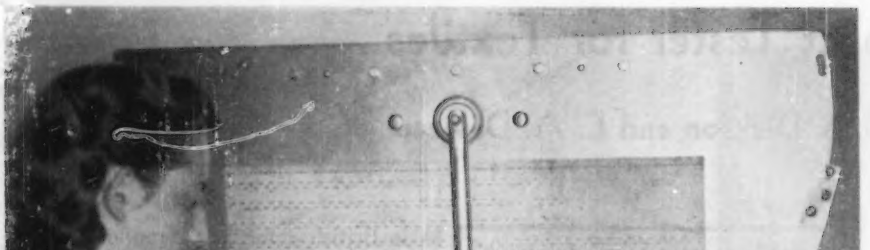

Fig. 1.—No. 1 Textile Impact Tester Arranged for Impact Tear Test Showing Position at Which Tear Starts.

chain extending to a stationary anchor. In this respect it is similar to the apparatus herein described when used for tear testing. Lang reported only results of ballistic tension tests, chiefly on fibers.

A difference in terminology is to be noted. The British use "ballistic"; we prefer "impact." The latter is American usage for similar testers employed for metals and plastics. In exterior ballistics the pendulum used to catch a projectile for measuring its velocity is characteristically different from the simple pendulum employed for textiles.

Evolution of the Tester

In 1943 an impact tester (tester No. 1) was constructed at the General Laboratories of the United States Rubber Co., after preliminary experiments on an impact instrument improvised from a Suter pendulum tension tester. During World War II, information on this instrument was furnished to the United States Quartermaster Corps, for whom one of the authors was a consultant, and an improved tester (tester No. 2) was constructed at the Jeffersonville Quartermaster Depot. This instrument had four scales of 196, 205, 545, and 810 in-lb capacity. Accessories permitted testing for impact tear and longitudinal tensile strength; tennis string could be stretched across the path of the pendulum bob and impact resistance determined. A third instrument (tester No. 3) was built at the Development Laboratory of the Textile Division of the United States Rubber Co., with a number of improvements. The capacity without weights is 196 in-lb, which capacity can be doubled or trebled by the addition of one or two pairs of weights. The height of drop is adjustable, which in effect provides for lower capacity.

The above instruments have been used for determining impact tear and tensile strength of a wide variety of textiles, including coated fabrics.

Description of the Instrument

Figure 1 is a photograph of the first specially constructed tester, No. 1. It is shown arranged for a tear test with the pendulum at the point where tear starts. The pendulum bob is supported by two strips of steel which straddle the disk carrying the scale. The scale is graduated in degrees, with the table for converting degrees into inch-pounds shown on the disk. The tester pictured has a capacity, without added weights, of 32.2 in-lb when dropped from the usual position, and 68.5 and 116.8 in-lb when weights in pairs are bolted to the pendulum bob. For reading the degrees, a lightweight cursor is hooked over the edge of the disk and held in place by a spring on the back, attached at the axis of the pendulum. The cursor does not show on the photograph as it is started from the bottom position where it is concealed by the pendulum. The cursor shows no overrun and the effect of friction is negligible. The pendulum is stopped by hand after it has completed its excursion.

Figure 2 is a photograph of the third instrument. With the legends it should be largely self-explanatory. A knurled nut at the axis controls the friction on the pointer to prevent overrunning. The instrument as pictured has a capacity of 196 in-lb and the scale is graduated to read directly in inch-pounds; the capacity is doubled or trebled by adding weights. The instrument is equipped with a level and leveling screws and a brake to stop the pendulum after it has completed its swing. The pointer should be of light weight to reduce momentum and eliminate overrunning with minimum friction.

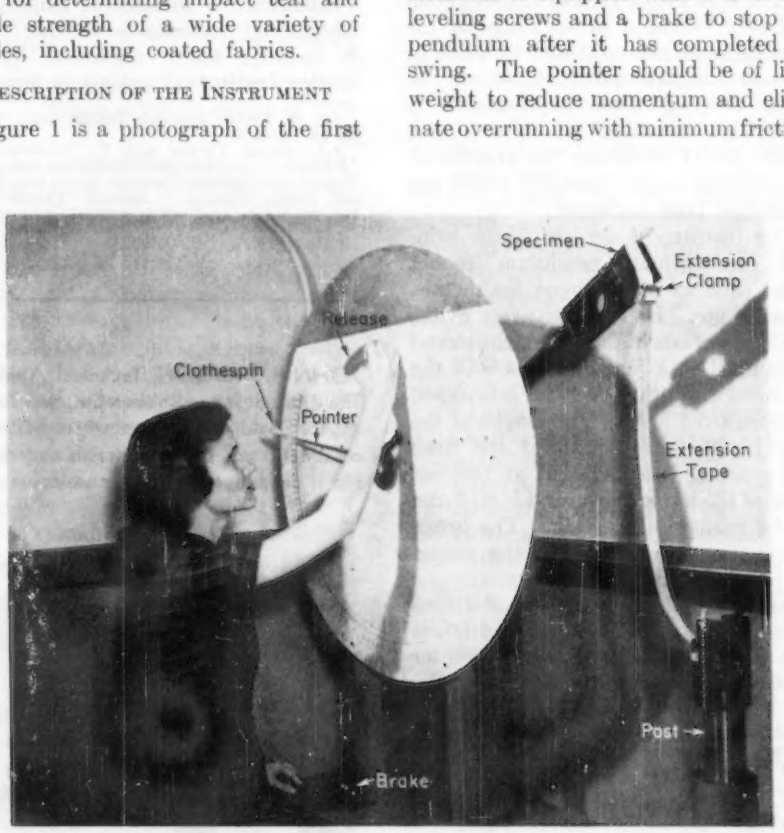

Fig. 2.—No. 3 Textile Impact Tester Arranged for Impact Tear Test with Pendulum in Drop Position.

The clamp for attaching the tape to one of the tabs of the specimen should be quick-acting for speed in testing, should clamp the fabric without any "give" of the fabric in the clamp, and should preferably be light in weight. In Fig. 3 the clamp is shown as devised to effect a compromise among these requirements. It operates with an eccentric cylinder similar to that on safety belts in airplanes. The eccentric is operated with a clock key, not shown in the drawing. It can be set to three positions for accommodating different thicknesses of fabric. Good results have been secured with the simplest of clamps—a commercial buckle consisting in effect of two D-rings, one slightly smaller than the other, with a tab threaded through the rings so that a pull tightens down on the fabric. The doubtful point here, however, is the possibility that there may be "give" at the clamp, especially with stiff fabrics, whereas the clamping action of the eccentric is positive.

Results with the tester, depending somewhat upon its arrangement, may be slightly affected by the extension tape and clamp. Whether or not this influence exists can be determined by dropping the pendulum with clamp and tape attached and releasing them at the low point; this can be done by using a thread of negligible strength to connect the extension clamp to the pendulum. Set the pointer behind the zero point on the scale the usual amount (see the following paragraph) and release the pendulum. Then connect with the thread and again release. If the swing-through is the same without and with the extension parts on the down swing, there is no effect. If an effect exists, it can be allowed for by a slight adjustment of the drop position.

When the friction required to prevent overrunning of the pointer is appreciable, it is desirable to minimize and standardize the effect. An impact tear test on No. 3 tester is conducted as follows. One tab of the die-cut specimen is clamped in the jaw of the bob of the pendulum and the other tab in the clamp on the tape extension. (Figure 4 shows the dimensions of a tear specimen for 1 in. length of tear and 4 in. length of tab.) The pendulum is raised, latched, released, and braked on the return swing. The first specimen in a set is an extra and for it the pointer starts with the pendulum and the end position is temporarily marked with a clothespin. For the recorded tests which follow, the pointer is set in line with the clothespin and should move forward with subsequent tests or the result is rejected (which has not yet occurred, however). By this procedure the pointer moves against the same relative amount of friction from test to test.

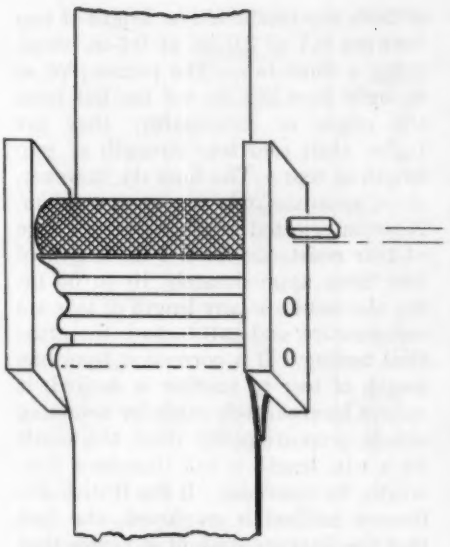

Fig. 3.—Quick-Acting Extension Clamp.

For exact results, the technique employed in the British Standard ballistic test eliminates the influences of certain variables and also takes care of the "end effect"—the tendency of the end yarns to pull out without rupturing. Two sets of specimens are used, one for 1-in. and the other for 4-in. lengths of tear. The difference between the results of the two is reported.

The tendency for the end yarns of some fabrics to pull out instead of breaking can be obviated by back-cutting. A cut is made between the same two yarns as that between the tabs. A back-cut is shown on the photograph of tester No. 1.

The following experiments on warp tear of a fabric illustrate the effect of back-cutting, the length of tear in this instance being 1 in. and the back-cut being $\frac{1}{4}$ in. The fabric had 50 ends and 40 picks per inch. To ascertain the effect of mistakes in lining up the two cuts, the back-cut was offset a counted number of yarns.

	Warp Impact Tear, in-lb	No. of Yarns Pulled Out
No back-cut	16.39	Average of 3.8
Back-cut between same yarns as main cut	17.06	None
Back-cut offset 2 yarns	17.01	None
Back-cut offset 4 yarns	17.37	None
Back-cut offset 6 yarns	17.33	None

With ordinary care in aligning the cuts, there should be no appreciable effects on impact tear even if the alignment is not perfect. There is no satisfactory way of correcting for the number of yarns which pull out. Instances have been encountered where the impact tear figures were higher when yarns pulled out than when this was prevented by back-cutting.

The procedure for testing impact tensile strength of strands and of strips of fabric raveled to 1 in. in width is simple. It is necessary to adopt the same length of specimen between grips when results are to be compared. This length as employed for tester No. 3 is 31 in. between jaws.

Impact strength is expressed in energy units, as distinguished from the practice of converting British ballistic and Elmendorf tear tests into force units. Since the test is essentially dynamic, it is preferable that the units reported express this fact.

Provision must be made for calibrating all testing instruments. There is little likelihood of change in the calibration of the impact tester, but this can be checked by weighing the horizontal pendulum (as later described).

Mathematics of the Pendulum

Textbooks on mechanics treat of the laws of the compound pendulum, but the following summary of relevant mathematical equations may be a convenience to anyone constructing or calibrating an impact tester. Units are in inches, pounds, and degrees:

W = weight of pendulum in pounds,
L = distance from axis of pendulum to center of gravity (balance pendulum on a knife edge and measure length to axis in inches),
WL = machine constant, and
θ = angle of the axis of the pendulum from the perpendicular

$$\text{Energy } E, \text{ in-lb} = WL\ (1 - \cos\theta)$$

After the pendulum is mounted, the machine constant can readily be checked without dismounting. Weigh in pounds the pendulum when horizontal (spirit level) at some known distance, X, from the axis. For example, a loop of cord can be clamped in the jaws of the pendulum bob, an accurate spring scale hooked into the loop, and the scale read when the pendulum is horizontal. According to the law of levers, the product of force multiplied by distance from the fulcrum to produce equilibrium requires the same numerical value as the product of weight by length when ap-

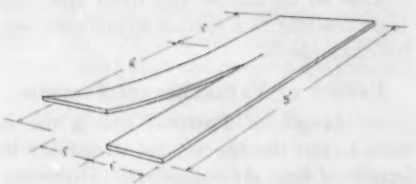

Fig. 4.—Dimensions of Impact Tear Specimen.

plied at any other point or

$$WL = FX = \text{machine constant}$$

Incidentally, when the pendulum is horizontal, $\theta = 90$ deg, cos 90 deg = 0, $(1 - \cos \theta) = 1$, and FX is the inch-pounds for a 90 deg swing-through of the pendulum.

The scale can be graduated in degrees from the perpendicular, which requires reference to a conversion table or graph of degrees into inch-pounds. Alternatively, the scale may be graduated directly in inch-pounds.

The attachment of the specimen is correctly at the center of percussion of the pendulum. This center can be located by timing the swings of the pendulum and using the equation:

$$T = 2\pi \sqrt{\frac{L}{g}}$$

$$L = 9.781T^2$$

where L is length from the axis to the center of percussion, T is the time in seconds for one complete to-and-fro swing of the pendulum, and g is the constant of gravitation (386 in. per sec per sec).

The velocity of the pendulum at impact can be computed from the equation:

$$\text{velocity, ft per sec, } v = 8.02 \sqrt{h}$$

where h is the height of drop in feet—that is, the vertical distance from the jaws in the drop position to the jaws when the pendulum hangs perpendicularly. For tester No. 3 the impact velocity from the usual drop position is approximately 12 ft per sec or 8 miles per hr.

As already indicated, the capacity can readily be increased by means of the addition of weights to the pendulum bob. The weights are bolted in pairs, one on each side of the bob. As a matter of convenience, the weights should be so selected that the original scale need only be multiplied by some simple number, 2, 3, etc.

When the capacity is reduced for low-strength textiles by lowering the drop point, thus utilizing the more extended bottom part of the scale, the computations involve subtracting the scale reading of the test from the scale reading for the free swing (or as the case may be, the free swing corrected for the effect of extension clamp and tape). For convenience in subtraction, it is desirable so to adjust the drop that the scale reading is a simple whole number, for example 50.

Effect of Variables on Testing

1. Length of Tear.—When a die is used to cut the specimens, variations in length of tear do not occur. However, the effect of length of tear may enter into the handling of the data. A series of tests was conducted on length of tear between 0.5 to 3.0 in. at 0.5-in. steps, using a short tab. The points plot as straight lines but do not fan out from the origin of coordinates; they are higher than zero tear strength at zero length of tear. The lines do, however, show approximately a common origin. None intersected another over a range of tear resistance for a 1-in. length of tear from approximately 10 to 65 in-lb; the results at any length of tear are comparative and satisfactory for practical testing. If a correction from one length of tear to another is desired, it cannot be accurately made by assuming simple proportionality (that the result for a 1-in. length is half that for a 2-in. length, for example). If the British difference method is employed, the fact that the lines are straight indicates that over the range from ½- to 3-in. length of tear it is immaterial which pair of lengths is adopted.

An intercept on the zero length of tear axis also occurred when long tabs, approximately 12 in. between jaws, were used. The total energy absorbed goes not only into tearing the fabric but also into stretching the tabs.

2. Width of Tab.—Since it is desirable for many reasons to die-cut the test specimens rather than cut them with shears, the effect of accidental variation in width of tab does not arise. However, experiments were made with 2-in. length of tear on a lightweight cotton fabric, using tabs approximately 12 in. between grips (without an extension tape), and ¼, ½, 1, and 1½ in. wide. Some of the ¼-in. specimens broke in tension. The apparent tear strength increased from 11.4 to 12.7 when tabs were narrowed from 1 to ¼ in. and decreased to 11.1 when widened to 1½ in. The differences are to be ascribed to energy absorbed in stretching the tabs, the narrower tabs stretching more than the wider. It is evident that, with the 1-in. width short tabs finally adopted, the effect of width is small.

3. Position of Pendulum at Start of Tear.—Unless marks are placed on the tabs for clamping, which would increase the cost of testing, the position of the pendulum when break occurs will vary slightly. Special experiments show that the effect of differences in the position of the pendulum likely to occur in practice is negligible. If desirable, however, the worker making the test can lower the pendulum after clamping and quickly note whether it is perpendicular when the tab and tape are taut. This precaution might be especially helpful in the case of a new operator until he gets the knack of clamping uniformly.

4. Height of Drop.—Impact tension tests were made on five cotton ply yarns at drops 102, 90, and 32 deg from the perpendicular. The averages were respectively 25.3, 24.5, and 23.0 in-lb, and the grand average coefficient of variation was 6.4 per cent. The differences in impact strength are not large but they increase consistently with height of drop; the explanation may be that the impact strength increases with impact velocity, corresponding to the known increase of static strength with rate of separation of the jaws.

5. Effect of Length on Impact Tension.—The impact tensile strength of a cotton tire cord was determined for lengths between the jaws of 31, 45, and 55 in. Over this range the results plotted as a straight line but did not extrapolate to the origin of coordinates.

Precaution:

The cursor (pointer) positively must not overrun. To test for overrunning, proceed as follows: drop the pendulum and pick up the pointer at, say, the top of the swing. Move the pointer back slightly from its stopping position and again drop; the pointer should move ahead. Again move slightly back and drop; the pointer should again move slightly ahead. If it does not there is overrunning, and the friction nut should be turned to increase the friction until overrunning ceases. Dry washers cut from old felt hats proved the most satisfactory of various materials investigated for controlling pointer friction.

Precision

Impact Tear, Static Strip Tension, Mullen Burst, and Elmendorf Tear Tests:

Warp impact tear in inch-pounds, warp static strip tension in pounds, Mullen burst in pounds per square inch, and warp Elmendorf tear in grams force were determined on a variety of uncoated and coated fabrics, ranging uncoated from 2.4 to 17.0 oz per sq yd, and including cotton and one nylon fabric. The average coefficients of variation are shown in Table I. Elmendorf tests were made on only seven of the samples.

TABLE I.—COEFFICIENT OF VARIATION OF IMPACT TEAR, STRIP TENSION, MULLEN BURST, AND ELMENDORF TEAR TESTS.

Number of Samples	Impact Tear, per cent	Strip Tension, per cent	Mullen Burst, per cent	Elmendorf Tear, per cent
16....	4.17	4.90	4.50	...
7....	3.98	5.01	3.75	4.01

Impact, Tongue, and Trapezoid Tear Tests:

It is the usual custom to employ the same tester for static tear tests as for tensile strength tests, with the consequence that in many instances the tear

strength may register as only a few pounds and the real extent of variation is unreadable on the scale. The figures in Table II are more comparable than is frequently the case, having been selected with this fact in mind. The fabric was a cotton duck, ten specimens being used for each test. The tongue test was single tongue and the static tests are averages of the traces on autographic charts.

TABLE II.—COEFFICIENT OF VARIATION OF IMPACT TEAR, SINGLE TONGUE TEAR, AND TRAPEZOID TEAR TESTS.

	Impact		Tongue		Trapezoid	
	Warp, in-lb	Filling, in-lb	Warp, lb	Filling, lb	Warp, lb	Filling, lb
Average tear strength.	39.9	31.7	[a]	11.4	62.8	13.4
Coefficient of variation, per cent.	5.3	5.8	[a]	6.9	15.4	10.8

[a] Tore across filling.

Impact and Static Tension Tests of Cord:

The coefficient of variation of 20 impact tests on a cotton tire cord was 2.18 per cent and for ten static tension tests 4.26 per cent.

Impact and Static Strip Tension Tests of Fabrics:

The figures in Table III apply to the fabrics on which test data appear in the following section. Five specimens of each were tested.

Summary on Precision:

The foregoing data show that the precision of the impact tests compares favorably with that of other textile tests. More frequently than not, the coefficient of variation is lower for the impact test than for the other tests with which it is compared.

Illustrative Data

Data illustrating impact tension tests of strands and fabrics and impact tear test of fabrics are shown below.

All tests were made under the usual standard conditions of approximately 65 per cent relative humidity and 70 F.

TABLE III.—COEFFICIENT OF VARIATION OF IMPACT AND STATIC STRIP TENSION TESTS.

Fabric	Impact		Static	
	Warp, per cent	Filling, per cent	Warp, per cent	Filling, per cent
Cotton:				
Sheeting....	14.0	7.4	6.2	6.3
Rug backing	3.5	15.0	3.5	11.1
Dynel:				
Duck.....	4.2	6.1	3.0	4.0
Duck.....	[a]	6.6	3.2	4.8

[a] Tore across filling.

TABLE IV.—COMPARISON OF IMPACT AND STATIC TENSION TESTS ON YARNS.

Nominal Cotton Count[a]	Measured Cotton Count Impact Specimens, *N*	Impact Tensile Strength, in-lb	Impact Break Factor	Static Tensile Strength, lb	Static Break Factor	Static Break Elongation, per cent
Cotton:						
6s/11.....	0.544	53.8	29.3	44.6	24.3	9.80
6s/8.....	0.763	35.1	26.8	30.8	23.5	9.23
7s/7.....	1.00	24.5	24.6	21.84	21.9	8.90
6s/6.....	1.03	23.6	24.3	22.49	23.1	8.00
6.75s/5.....	1.33	19.3	25.7	17.90	23.8	9.05
6.75s/3.....	2.31	8.37	19.3	9.40	21.7	7.07
10s/4.....	2.47	8.32	20.6	8.60	21.2	7.00
Averages			24.4		22.8	7.18
6s/1.....	6.16	3.43	21.1	3.00	18.5	7.54
8s/1.....	7.97	2.84	22.6	2.76	22.0	7.94
10s/1.....	9.95	1.70	16.9	2.03	20.2	6.92
Averages			20.2		20.2	7.47
Dynel:						
10s/6.....	1.62	62.2	96.0	13.60	22.1	39.65
10s/5.....	1.97	59.6	117.6	11.92	23.5	36.42
12s/6.....	2.18	50.9	110.7	12.20	26.5	30.75
12s/3.....	3.92	23.9	93.6	4.98	19.5	28.55
Averages			104.8		22.9	33.84
12s/1.....	12.64	5.27	66.6	1.42	17.9	29.97
10s/1.....	10.35	9.31	96.4	1.94	20.1	31.00
Averages			81.5		19.0	30.49

[a] Note.—Cotton count as a measure of yarn size is in reciprocal units of linear density, and yarn fineness increases with the numerical value of cotton count. The equivalent cotton count of a ply yarn can be computed approximately by dividing the cotton count of the singles, the figure before the slant line, by the number of plies, the figures after the slant line.

TABLE V.—IMPACT STRIP TENSILE STRENGTH OF FABRICS.

Weight, oz per sq yd	Yarns per Inch		Cotton Count		Impact Tensile		Impact Break Factor		Static Break Factor	
	Warp	Filling	Warp	Filling	Warp	Filling	Warp	Filling	Warp	Filling
Cotton:										
4.18..	71	58	23.7s/1	24.7s/1	31.4	52.7	10.5	22.4	20.1	23.0
9.02..	30	26	4.8s/1	4.8s/1	104	108	16.7	19.9	14.9	17.9
Dynel:										
6.16..	37	28	16.5s/2	8.0s/1	353	216	78.7	61.7	22.5	23.5
10.5...	38.3	28.5	10.3s/2	10.0s/2	[a]	466	[a]	81.7	21.1	18.6

[a] Did not break.

TABLE VI.—IMPACT TEAR STRENGTH

Weight, oz per sq yd	Nominal Cotton Count		Yarns per Inch		Impact Tear, in-lb		Impact Tear Factor		Static Tensile Factor	
	Warp	Filling	Warp	Filling	Warp	Filling	Warp	Filling	Warp	Filling
Cotton										
4.18...	24s/1	25s/1	71	58	16.6	15.3	5.54	6.52	19.7	21.7
14.8....	10s/4	10s/4	23	24	70	74	7.69	7.70	19.7	18.2
26.3....	8s/7	7s/7	16	20	120	205	8.28	10.0	17.7	19.6
Dynel										
3.9....	20s/1	20s/1	53	55	20.0	17.5	7.99	6.08	18.0	16.0
9.1....	10s/2	10s/2	38	29	45.3	46.3	7.07	8.24	21.7	21.0
18.6....	10s/6	10s/5	22	24	108	107	8.76	9.72	20.0	21.3

Impact Tensile Strength of Yarn:

The results shown in Table IV were secured on the No. 1 machine, using a 29-in. length of specimen between the jaws. Singles and ply yarns of both cotton, a low stretch fiber, and dynel, a high stretch fiber, were investigated. In addition to impact tensile strength on ten specimens, static tensile strength and break elongation on five specimens were determined for comparison. For comparisons of yarns of different sizes, the strength per unit linear density is useful; the break factors are defined as follows:

$$\text{yarn static break factor} = \text{cotton count} \times \text{break load, lb}$$

$$\text{yarn impact break factor} = \text{cotton count} \times \text{impact energy, in-lb}$$

Because of the variability of yarns, the cotton count of the yarn actually broken in the impact test was determined by cutting out the broken yarn (of known length) at the jaws and weighing the broken parts. This refinement was not used for the tension test, the cotton count being that determined by the customary skein method.

The effect of elongation in increasing the impact tensile strength is clearly evident from the data. Static break factors are roughly the same for the cotton and dynel yarns, but the impact

figures for dynel (static break elongation approximately 32 per cent) are roughly four times those of cotton (static break elongation approximately 7 per cent). The break elongation of cotton fiber is approximately 7 per cent, that of dynel fiber approximately 35 per cent.

Impact Strip Tension:

For data in Table V specimens were raveled to 1-in. width, with length between the jaws of 31 in. For comparative purposes and for design of fabrics for impact tension, the impact strip break factor is useful and has been included. This factor is the impact break energy in inch-pounds per unit linear density of the yarns in 1-in. width of fabric, the linear density being in reciprocal units of cotton count. The definition is:

$$\text{impact break factor} = (\text{in-lb} \times \text{cotton count})/\text{yarns per in.}$$

Static break factors of 1 by 3 raveled strip tension results are included for comparison. All fabrics are plain weave. All figures are averages of five specimens.

Considering only the filling data (the cotton warp yarns are sized) the static break factors are seen to be approximately the same for dynel as for cotton, whereas the impact break factor for dynel is approximately three to four times that for cotton. This difference is to be ascribed to the greater break elongation of dynel fiber (approximately 35 per cent) as compared with cotton (approximately 7 per cent).

Impact Tear:

Impact tear data have been selected for a variety of staple-yarn fabrics from tests made on the No. 3 machine, the specimens having 1-in. length of tear and tabs 1 by 4 in. Warp figures mean that warp yarns are ruptured, with the direction of tear parallel to the filling yarns, and conversely. All fabrics are plain weave.

For comparison of intrinsic tear resistance and for design of fabrics for tear resistance, impact tear factors are needed corresponding to similar tension factors for fabrics. Impact tear factors are the inch-pounds per unit linear density of the yarns broken across a 1-in. width of warp or filling. Impact tear factor is defined as:

$$\text{impact tear factor} = \frac{\text{in-lb} \times \text{cotton count}}{\text{number of yarns per in.}}$$

Table VI shows nominal cotton counts and yarns per inch, but measured figures were used in computing the impact tear factors. Static strip break factors are included.

Comparative Cost of Textile Test Methods

The figures in Table VII are intended only to give an idea of how the cost of the impact tear test compares with that of the static tension tests in current use. Results on other fabrics will obviously differ from those on this specific fabric. The impact tests were made on the No. 3 tester.

The times required for operators to prepare specimens, conduct tests, and record results have been clocked for impact tear, static strip tension, and grab tension tests on a cotton sheeting 81 in. wide, 4.2 oz per sq yd, 71 × 58. The times are for ten specimens each of warp and filling—that is, a total of 20 recorded readings by each method. The time for impact tear includes preparing the extra specimen for setting the clothespin, and that for grab includes pencilling the line which insures that the upper and lower jaws grip the same yarns (one edge was raveled and a template used to draw the line parallel to the yarns under test).

TABLE VII.—COMPARISON OF TIMES REQUIRED FOR TESTS.

Operation	Static Strip, min	Grab, min	Impact Tear, min
Die cut (arbor press)	25	20	25
Ravel or pencil grab	40	6	..
Break	20	25	35
Read stretches	5	5	..
Average charts and breaks	4	3	2
Total time	94	59	62

Further, the time required for making impact tear tests has been compared with the times for making three static tear tests in current use. Relative average figures for one cotton and one dynel duck are: impact 16 minutes, single tongue 26, double tongue 18, and trapezoid 19.

Acknowledgments:

We are indebted to S. M. Cadwell, Director of the Research and Development Department, and to B. H. Foster of our General Laboratories for permission to publish this paper. W. H. McKnight, Jr., carried out the machine design of the first tester, and S. G. Illingworth assisted in refining the method of test. The following members of the staff of the Development Laboratory of the Textile Division have contributed to improvements in the instrument and method of test: E. A. McMaster, in charge of the testing laboratory, R. A. Hobbs, Julius Blum, and H. P. Riley, who built the third instrument and incorporated improvements.

Bibliography on Steam Contamination

The American Society of Mechanical Engineers, 29 W. 39th St., New York 18, N. Y., $2.50

Steam contamination in its broad sense might include all phases of boiler water treatment as well as many aspects of boiler design and operation. For the purpose of this bibliography, compiled by the Steam Contamination Subcommittee of the Joint Research Committee on Boiler Feedwater Studies, only those references dealing directly with steam contamination have been included.

From books and periodicals of several countries have been culled and published in this bibliography 1085 references to information on contaminants in steam and how to determine them, the mechanical and chemical factors contributing to steam contamination, such as deposits, corrosion, and plant operation; and corrective measures. These embrace equipment design, operating conditions, pretreatment of boiler feedwater, antifoam treatment, control of mineral content of boiler water, and volatile inhibitors for presenting condensate system corrosion.

References are arranged alphabetically by author's name. Each reference is numbered for ease in identification. A short annotation or abstract is included with each reference where the original material was available for examination. A classified index groups the subjects under seven main headings and 102 subheadings. Some of the references relate to early investigations but the bulk of them cover the literature from 1920 to 1952.

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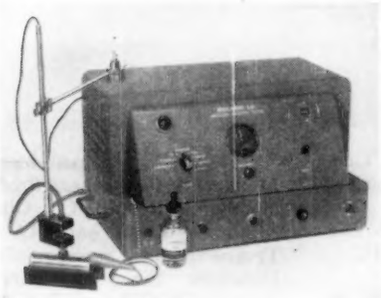

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PERSONALS...

News items concerning the activities of our members will be welcomed for inclusion in this column

NOTE—These "Personals" are arranged in order of alphabetical sequence of the names. Frequently two or more members may be referred to in the same note, in which case the first one named is used as a key letter. It is believed that this arrangement will facilitate reference to the news about members.

The following ASTM members, active for many years in various phases of the Society's technical work, were among 27 American Chemical Society 50-year members feted at the Spring meeting of ACS in Kansas City: **Carl S. Miner,** of the Miner Laboratories, Chicago, Ill.; **Stanislaus Skowronski,** Research Dept., Raritan Copper Works, International Smelting and Refining Co., Perth Amboy, N. J.; and **Robert B. Sosman,** Visiting Professor of Ceramics at Rutgers University, New Brunswick, N. J.

Cameron A. Baker, Research Engineer, United States Testing Co., Hoboken, N. J., has been named Chairman of the Textile Section of the New York Board of Trade for 1954.

Louis J. Baudis has been elected Vice-President in Charge of Manufacturing, Bullard Co., Bridgeport, Conn. Mr. Baudis joined the company in 1935 and had served as Chief Engineer since 1947.

Ralph H. Bescher, Manager, Technical Dept., Koppers Co., Inc., Wood Preserving Division, Orrville, Ohio, has been elected Vice-President of the Forest Products Research Society.

Charles Bogin has retired as Chief Lacquer Chemist, Research Dept., Commercial Solvents Corp., Terre Haute, Ind. He is succeeded by **Robert R. Bennett.**

Humbert Rodriguez Causing, formerly Civil Engineer, Porter-Urquhart, Skidmore, Owings & Merrill, Casablanca, French Morocco, is now on the Staff at Princeton University, Princeton, N. J.

Robert F. Duncan has been made Manager of the Package Products Division of Calumet Refining Co., Chicago, Ill. He continues in the capacity of Secretary-Treasurer and a member of the Board of Directors. Since 1943 Mr. Duncan has represented Calumet Refining's Sustaining Membership in ASTM and has served on Committee D-2 on Petroleum Products and Lubricants.

Gustav Egloff, Director of Research, Universal Oil Products Co., Des Plaines, Ill., has been named to receive the 1954 Carl-Engler-Medaille Germany's highest award in the field of mineral oil science. Presentation will be made during the Congress of the German Institute of Petroleum and Coal at Essen in October, at which time Dr. Egloff will give an address on "Chemistry in the Modern Oil Industry."

Henry D. Evans retired as Chemist, Pepperell Manufacturing Co. Laboratory, Biddeford, Me., and has been succeeded by **Joseph W. Cummings, Jr.**

S. H. Graf has been named Professor Emeritus, Mechanical Engineering, Oregon State College, Corvallis, Ore., having retired April 1 as Director of the Engineering Experiment Station at the College.

W. F. Griffin, formerly Superintendent, Receiving Tube Plant, Crosley Division, Avco Manufacturing Corp., Batavia, Ill., is now Manager of Engineering, Westinghouse Electric Corp., Bath, N. Y.

James W. Halley has been appointed Assistant Superintendent of Research and Development, Inland Steel Co., Indiana Harbor, Ind.

Margaret B. Hays, Supervisory Technologist of Textiles, Aeronautical Materials Laboratory, Naval Air Material Center, Philadelphia, Pa., was featured recently in the first of a series of articles by the Center newspaper, "Air Scoop," to inform employees of the different kinds of jobs held by NAMC women. Following a review of Miss Hays' career, the article discussed several of the projects under way at the "Lab"—testing of wool-synthetic combinations made into pile fabrics, testing upholstery fabrics for aircraft use, development of fabrics for flight clothing, evaluating mothproofing compounds, and development of a method of applying a flame-resisting compound to a garment when laundered. Quoting from the concluding

(*Continued on page 96*)

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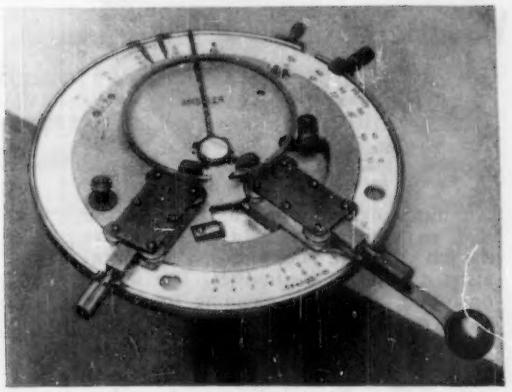
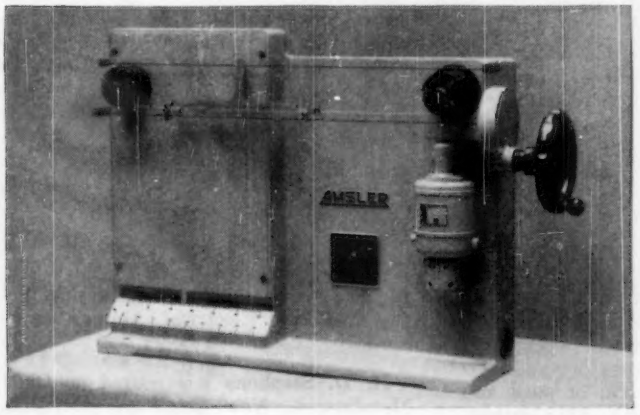


THE PISTON RING TESTER measures the force required to open or close the ring and operates practically without friction. The bending moment is distributed over the entire circumference of the ring. A simple formula converts to lateral pressure against the cylinder wall. The instrument may be used to determine the maximum bending moment at fracture. It can accommodate rings from 2 to 6 inches diameter and has 5 ranges of 10, 20, 50, 100 and 200 inch pounds.



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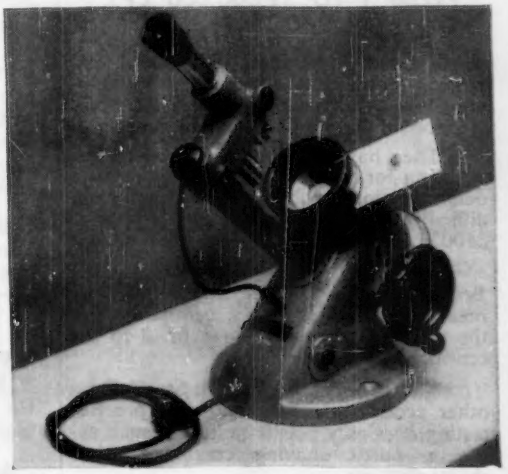

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(*Continued from page 94*)

paragraph: "The over-all work done through this competent supervisor results in greater comfort, economy, and durability of many Navy products . . . contributions of a woman at work at NAMC." In ASTM Miss Hays participates in the work of Committee D-13 on Textile Materials, serving on many subgroups, also is a member of Committee D-11 on Rubber and Rubber-Like Materials and of its Subcommittee on Tests for Coated Fabrics.

Elmo C. Higginson, Materials Engineer, U. S. Bureau of Reclamation, Denver, Colo., is with the Snowy Mountains Hydro-Electric Authority, New South Wales, Australia, for a 2-year period.

Alfred W. Hoffman, formerly Technical Director, Container Laboratories, is now Quality Control Manager, Robert Gair Co., Inc., New York City.

Leon E. Hoogstoel has been elected a Vice-President of Behr-Manning Corp., Troy, N. Y. He had been Technical Director since 1945.

Herbert Insley, internationally known for his researches in the microstructure and chemistry of mineral products, recently retired as Chief of the Mineral Products Division of the National Bureau of Standards. He is remaining in Washington, D. C., having opened offices as a Consulting Mineralogist.

Stanley J. Johnson, formerly Chief Engineer, Greer & McClelland, Montclair, N. J., is now associated with Moran, Proctor, Mueser & Rutledge, New York City.

J. S. Jorczak has been elected a Vice-President of the Thiokil Chemical Corp., Trenton, N. J. He had been Manager of the Technical Service and Production Departments.

John W. Juppenlatz and associates, James J. Blauch and Leroy G. Miller, all formerly with Lebanon Steel Foundry, and all with 28 or more years of broad experience in the production of steel and alloy castings, have announced the opening of the Quaker Alloy Casting Co., Myerstown, Pa., for the production of small carbon, low-alloy, stainless, and high-alloy castings.

Eric B. T. Kindquist, formerly with Eastwood Nealley Corp., Belleville, N. J., is now associated with the The Overlakes Corp., Garfield Wire Division, Garfield, N. J.

Vernon G. Leach has retired as Director of Research, Peabody Coal Co., Chicago. He now resides in Homestead, Fla. (605 North West 10th St.).

Alfred J. Porter, Manager, Bridgeport, Conn., plant of Heppenstall Co., was elected a Vice-President of the company in Pittsburgh, Pa.

Frank W. Reinhart, Senior Chemist, Organic Plastics Section, National Bureau of Standards, Washington, D. C., has been elected National Secretary of the Society of Plastics Engineers, Inc.

Edward A. Reynolds, formerly Quality Manager, Conmar Products Corp., is now with Ronson Art Metal Works, Inc., Newark, N. J., in a similar capacity.

John D. Ritchie, Douglas Fir Plywood Assn., Tacoma, Wash., has been elected for a 3-year term as Northwest Regional Board Member of the Forest Products Research Society.

E. S. Robb has been promoted to Manager of Manufacturing Engineering, Shell Chemical Corp., New York City.

A. O. Schaefer, Vice-President in Charge of Engineering and Manufacturing, Midvale Co., Philadelphia, Pa., and current ASTM Director, has been named Delaware Valley Metals Man of the Year by the Philadelphia Chapter of the American Society for Metals.

Edwin T. Sherwin, Chief Engineer, American Linen Supply Co., Chicago, Ill., who was recently elected a member of the Production Problems Committee of the Linen Supply Assn. of America, headed the Production Section of the National Convention of the Association in late April in Chicago.

Murray C. Slone, formerly associated with the National Bureau of Standards, Washington, D. C., is now Chemical Engineer, Alsynite Co. of America, San Diego, Calif.

G. Frederick Smith, Professor of Chemistry, University of Illinois, is 1954 recipient of the American Chemical Society Fisher Award. Known the world over for his development of new techniques and methods in analytical chemistry, Professor Smith is recognized by the ACS Award for his many contributions in this field over a lifetime of intense devotion to research, instruction, and service.

Hoyt P. Steel, Executive Vice-President, Benjamin Electric Mfg. Co., Des Plaines, Ill., has been elected a Vice-President of the National Electrical Manufacturers Assn.

H. D. Stephens has retired as Chief Metallurgist, New Departure Division, General Motors Corp., Bristol, Conn. He is succeeded by Charles E. Norton.

Samuel P. Tauber, formerly with Dispersions Process, Inc., is now with the U. S. Rubber Co., Naugatuck Chemical Division, New York City, in the capacity of Sales Agent.

Helmut Thielsch has been appointed Metallurgical Engineer, Industrial Piping Division, Grinnell Co., Inc., Providence, R. I. For the past three years he had been with the Welding Research Council of the Engineering Foundation.

William D. Thomas, formerly Coordinator of Research and Production, Petroleum Chemicals Dept., American Cyanamid Co., New York City, has joined Southwest Research Inst., San Antonio, Tex., as Fuels and Lubricants Technologist.

E. D. Vancil of the Cincinnati Milling Machine Co., Cincinnati, Ohio, has been moved from Manager of Engineering to full management of the Machinery Division of the company which recently has added a Machine Tool Division.

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NEW MEMBERS...

The following 58 members were elected from March 1 to March 29, 1954, making the total membership 7603 . . . Welcome to ASTM

Note—Names are arranged alphabetically—company members first, then individuals

CHICAGO DISTRICT

De Ross, Alan B., Chief Metallurgist, Advance Aluminum Castings Corp., 2742 W. Thirty-sixth Place, Chicago 32, Ill.

Martin, Kedwick R., Quality Control Engineer, Fort Wayne Corrugated Paper Co., Hartford City, Ind.

Mykkanen, Donald L., Graduate Assistant, Department of Mechanical Engineering, University of Illinois, Urbana, Ill. [J]*

Neff, John M., Assistant Manager, Ceramics and Minerals Dept., Armour Research Foundation, 10 W. Thirty-fifth St., Chicago 16, Ill.

Pavesic, E. J., Director of Research, Lindberg Steel Treating Co., 1975 N. Ruby St., Melrose Park, Ill.

Sleeper, Louis G., Research Assistant in Highway Engineering, Department of Civil Engineering, University of Illinois, Urbana, Ill. For mail: 708 S. First St., Apt. 1, Champaign, Ill. [J]

Yancey, R. W., Chief Metallurgist, Fansteel Metallurgical Corp., 2200 Sheridan Rd., North Chicago, Ill.

CLEVELAND DISTRICT

Kelly, Thomas M., Assistant Director of Research, The Master Builders Co., 7016 Euclid Ave., Cleveland, Ohio. For mail: 6515 Morgan Ave., Cleveland 27, Ohio.

DETROIT DISTRICT

Fruehauf Trailer Co., A. E. Williams, Vice-President in Charge of Engineering, 10940 Harper, Detroit 32, Mich.

Buckingham, C., Metallurgist, Detroit Gasket and Manufacturing Co., Belding, Mich. For mail: 207 W. Division St., Rockford, Mich.

Krupp, Roland G., Technical Superintendent, Technical Dept., Mueller Brass Co., 1925 Lapeer Ave., Port Huron, Mich.

Paulsen, Arnold G., Supervisor of Laboratory, Grand Blanc Tank Plant, General Motors Corp., Grand Blanc, Mich.

NEW ENGLAND DISTRICT

Perkins and Son, Inc., B. F., B. Q. Haynes, Manager, Mullen Tester Div., Box 388, Holyoke, Mass.

Dittami, Francis, R., Consulting Engineer, B. Perini and Sons., Inc., Montwait Ave., Framingham, Mass.

Jacobs, Charles J., Supervisor Technical Development, Adhesives Div., Dewey & Almy Chemical Co., 62 Whittemore Ave., Cambridge 40, Mass.

Shortle, Walter C., Head of Chemical and Metallurgical Lab., Scott and Williams, Inc., Union Ave., Laconia, N. H.

NEW YORK DISTRICT

Bancroft and Sons Co., Joseph, Robert B. Hutchinson, Group Leader, Engineering Section, % Alexander Smith, Inc., Yonkers 1, N. Y.

Resistoflex Corp., Benjamin M. Walker, Chief Chemist, 39 Plansoen St., Belleville 9, N. J.

Garner, H. Mills, Vice-President, Melberk, Inc., 420 Lexington Ave., New York 17, N. Y.

Haybrook, Stephen H., Head, Soils and Concrete Control, Niagara Mohawk Power Corp., Banquette River Project, Box 7, Potsdam, N. Y. For mail: Box 363, Potsdam N. Y.

Henry, Robert G., Chief Metallurgist, The Lithium Co., 111 Sylvan Ave., Newark, N. J. For mail: 47 D Bruan Place, Clifton, N. J.

Palmer, Robert B., Chief Metallurgist, Remington Rand, Inc., Laboratory of Advanced Research, Wilson Ave., South Norwalk, Conn.

Watling, Robert G., Engineer, Wire and Cable, Bell Telephone Laboratories, Murray Hill, N. J. For mail: 2 Dellwood Ave., Morristown, N. J.

Whittaker, H., Research Director, American Rock Wool Corp., Research Div., South Plainfield, N. J.

OHIO VALLEY DISTRICT

Klinger, Richard F., Materials Engineer, Wright Air Development Center, United States Air Force, Wright-Patterson Air Force Base, Ohio. For mail: 332 B Seventeenth St., Vandalia, Ohio.

U. S. Naval Ordnance Plant, Library, Twenty-first St. and Arlington Ave., Indianapolis 12, Ind.

PHILADELPHIA DISTRICT

Harlow, James H., Mechanical Engineer, Philadelphia Electric Co., 900 Sansom St., Philadelphia 5, Pa.

PITTSBURGH DISTRICT

Horne, G. T., Assistant Professor, Department of Metallurgical Engineering, Carnegie Institute of Technology, Pittsburgh 13, Pa.

Hutchinson, G. E., Supervisor, PE & C Dept., REM-CRU Titanium, Inc., Midland, Pa.

ST. LOUIS DISTRICT

Sherman, Arant H., Vice-President, Alter Co., 1701 Rockingham Rd., Davenport, Iowa.

SOUTHERN CALIFORNIA DISTRICT

Bishop, John F., Assistant General Manager, Beckman Instruments, Inc., 2500 Fullerton Rd., Fullerton, Calif.

French, Gordon M., Facilities Engineer, Douglas Aircraft Co., Inc., 3855 Lakewood Blvd. For mail: 4810 E. Willow St., Long Beach 15, Calif. [J]

Stefano, Nicholas M., Chief Engineer, American Helicopter Co., Inc., 1800 Rosecrans Ave., Manhattan Beach, Calif.

SOUTHWEST DISTRICT

Cretie, Paul D., President, Texas Testing Laboratories, Inc., 1416 Young St., Dallas 1, Tex.

Griffin, Joel H., Sales Representative, The Refinery Supply Co., Box 44, Houston 1, Tex.

Ketchbaw, Jewelle, Manager, Industrial Welding and Testing Laboratory, 224 Hamilton St., Houston 2, Tex.

Stern, Lyles A., District Manager, Pittsburgh Testing Laboratory, 150 Payne St., Dallas, Tex.

WASHINGTON (D. C.) DISTRICT

Reynolds Tobacco Co., R. J., Peter C. Markunas, Director, Analytical Research, Winston-Salem 1, N. C.

Blood, A. P., "Auburn," North Post Office, Mathews County, Va.

Hartman, George S., Specifications Consultant, Procurement Operations Div., Small Business Administration, Lafayette Bldg., Washington 25, D. C. For mail: 4105 N. Fourth St., Arlington 3, Va.

Larson, Clarence E., Materials Engineer, Division 2, Bureau of Public Roads, 74 W. Washington St., Hagerstown, Md.

(*Continued on page 100*)

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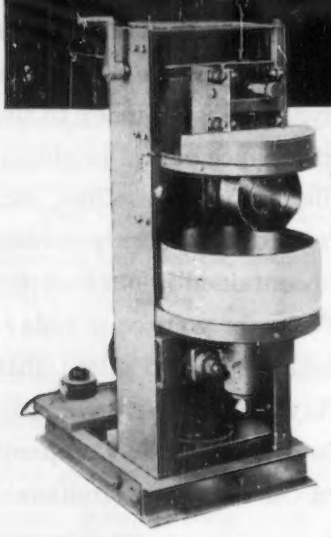

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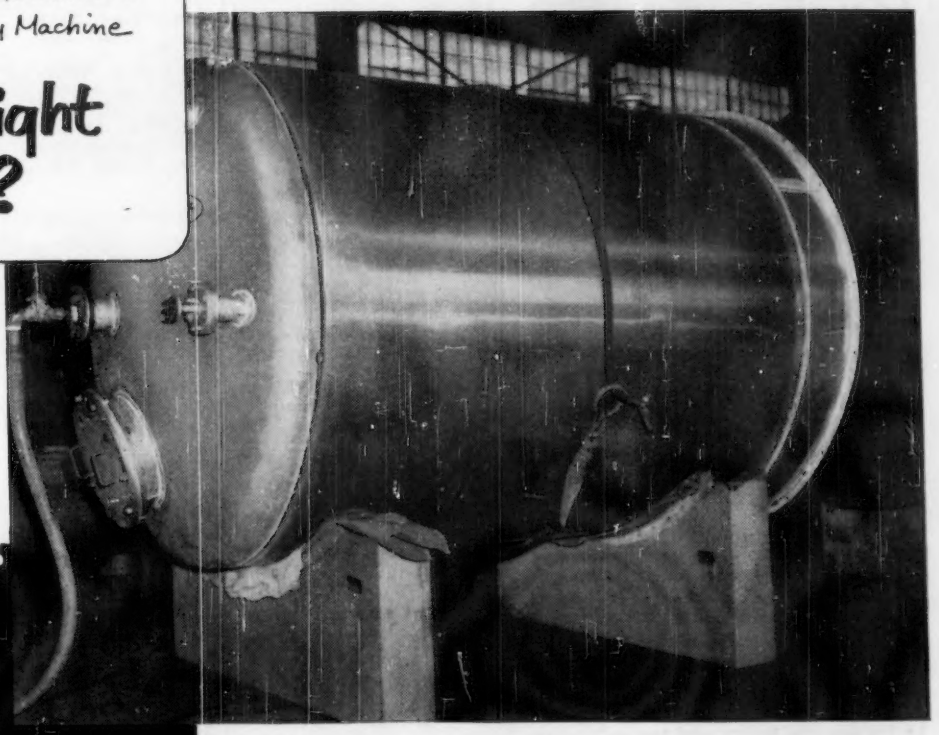

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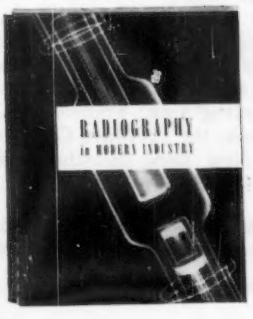

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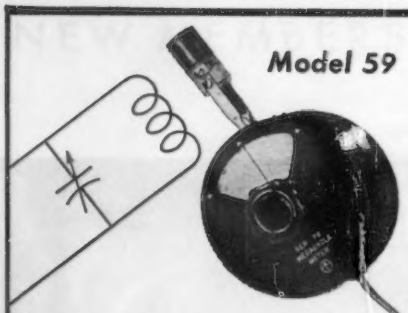

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(*Continued from page 98*)

Thulman, Robert K., Consulting Engineer, 2913 Stanton Ave., Silver Spring, Md.

WESTERN NEW YORK-ONTARIO DISTRICT

Holbert, H. C., Finishing Supervisor, Easy Washing Machine Corp., Solar and Spencer Sts., Syracuse 1, N. Y.

Schutz, Russell E., Chemist, Buffalo Weaving and Belting Co., 260 Chandler St., Buffalo 7, N. Y.

Weiler, Charles B., Vice-President, Insulation, Earl Paint Corp., 240 Genesee St., Utica 2, N. Y. For mail: Street Rd., Westtown, Pa.

UNITED STATES AND POSSESSIONS

Benson, Jewell R., Bituminous Engineer, Rubarite, Inc., 141 W. Jackson Blvd., Chicago 4, Ill. For mail: 1628 Glencoe St., Denver 7, Colo.

Butler, John L., Manager, Laboratory and Inspection Service, Hardwood Plywood Inst., 1012 Crescent Ave., N. E., Atlanta, Ga.

Harllee, John W., Jr., District Manager, Pittsburgh Testing Laboratory, 4301 N. W. Seventh St., Miami, Fla.

Mitchell, Leonard J., Materials Engineer, U. S. Bureau of Reclamation, Denver Federal Center, Denver, Colo. For mail: 376 S. Sherman St., Englewood, Colo.

OTHER THAN U. S. POSSESSIONS

Fábrica de Hilados y Tejidos del Hato, Manuel Alvarez L., Chief of Production, Apartado Nacional 14, Aéreo 698, Medellin, Colombia.

Betournay, Joseph Noe, Designing Engineer, Department of Transport, Room 332, Hunter Bldg., Ottawa, Ont., Canada.

Clark, C. G., Refinery Manager, Atlantic Sugar Refineries, Ltd., St. John, N. B., Canada.

Livis, Seymour, Materials and Process Engineer, Fleet Manufacturing, Ltd., Fort Erie, Ont., Canada.

Mayo, F., Refinery Manager, Esso Petroleum Co., Ltd., Fawley, Southampton, England.

Pryce, Arthur Andrews, Chief Mechanical Engineer, South Australian Railways, North Terrace, Adelaide, South Australia. For mail: Box 401, B.G.P.O. Adelaide, South Australia.

Stanley, H. H., Chief Metallurgist, Lysaght Division, The Steel Co. of Wales, Ltd., Orb Works, Newport, Mon., England.

Verbestel, Jean, Manager, Laboratoire Reignier and S. A. Verker, Brussels, Belgium.

Yarsley, V. E., Managing Director, Dr. V. G. Yarsley (Research Laboratories), Ltd., "Oaklands" Clayton Rd., Hook, Surbiton, Surrey, England.

* J denotes members.

DEATHS...

Jacques Louis Bienfait, Chemical Engineer and Partner, Koning & Bienfait, Amsterdam, The Netherlands (February 10, 1954). Member since 1946.

Paul H. Geiger, Research Physicist, University of Michigan, Ann Arbor, Mich. Representative of the University of Michigan on Committee C-20 on Acoustical Materials, and on its Subcommittee I on, Sound Absorption, since the organization of the committee in 1949. A member of the Physical Society and Acoustical Society, Dr. Geiger's efforts had been concentrated on the study of photoelectric effects, direct conversion of light energy to electrical energy, color analysis, reduction of machine noises, and measurement of acoustic properties of materials.

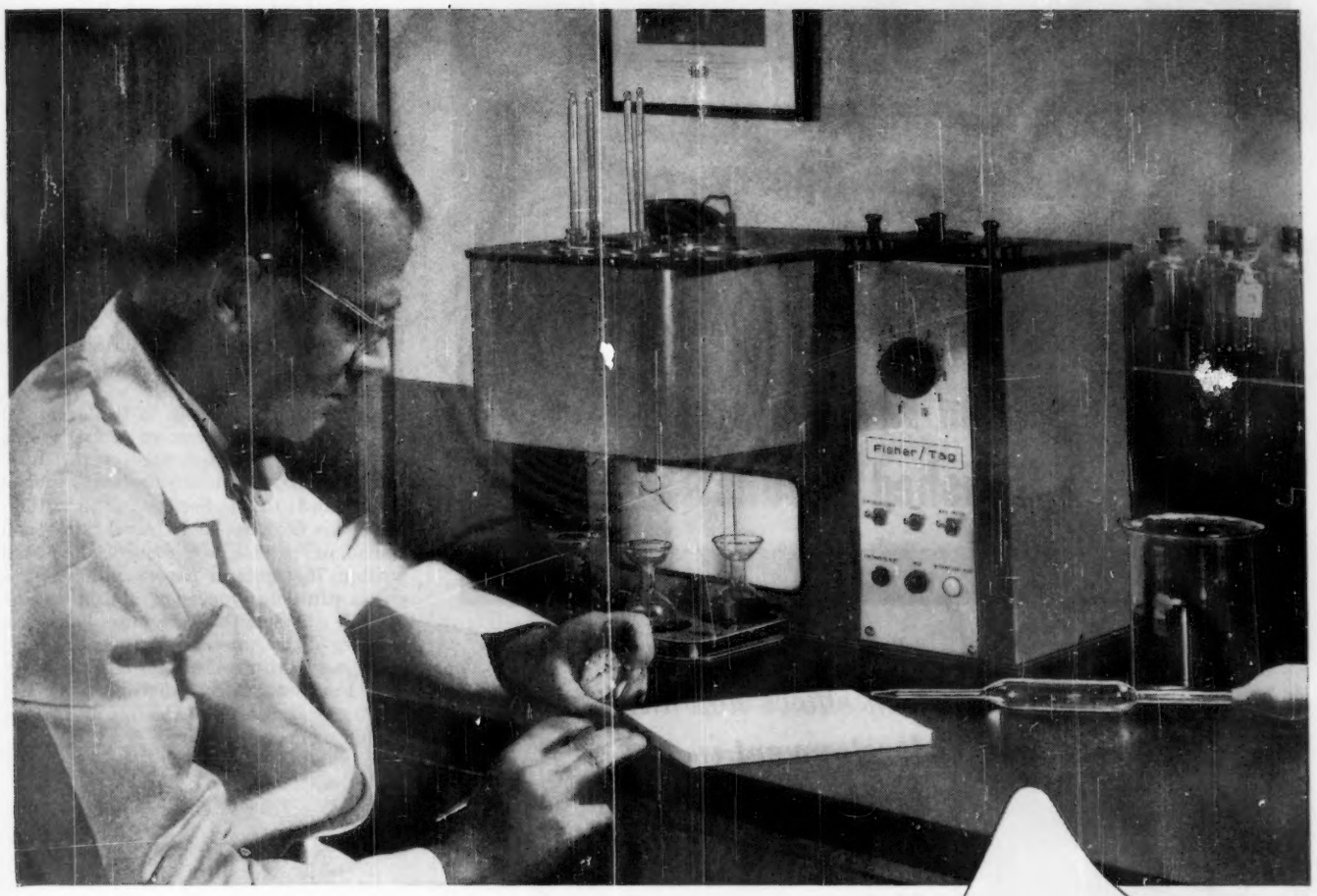
Samuel J. Leonard, Professor of Civil Engineering at Drexel Institute of Technology, Philadelphia, Pa. (March 8, 1954). Member of ASTM for 22 years and former member of Philadelphia District Council. On the Drexel Institute faculty since 1925, Mr. Leonard was previously affiliated with the Raymond Concrete Pile Co., the B. F. Goodrich Co., the Pennsylvania Department of Highways, and Columbia University.

John J. Paine, Chief Engineer, Bureau of Tests of the Pittsburgh Department of Public Works, Pittsburgh, Pa. (March 20, 1954). Member of ASTM since 1922 and a former vice-chairman of the Pittsburgh District Council. Through the years Mr. Paine had been very active in a number of the technical committees including Committee C-9 on Concrete and Concrete Aggregates, C-15 on Manufactured Masonry Units, D-4 on Road and Paving Materials, and D-8 on Bituminous Waterproofing and Roofing Material; also had served on ASA Sectional Committee on Road and Paving Materials. A graduate of Ohio State University and a Navy veteran of World War I, he had worked in his earlier years for the City of Lima, Ohio, also for the United States Ordnance District at Homestead, Pa. He had been with the Pittsburgh Department of Public Works for the past 32 years. In addition to ASTM, he was a member of a number of technical and scientific groups, including the National Professional Engineers and the American Chemical Society.

Robert W. Steigerwalt, Metallurgical Adviser (Retired), Railroad Materials and Commercial Forgings, United States Steel Corp., Pittsburgh, Pa. (March 21, 1954). Affiliated with ASTM since 1919, Mr. Steigerwalt's intensive activity in the technical work of the Society had been concentrated in Committee A-1 on Steel, where he had served on the Advisory Group and a number of the subcommittes, heading the Subcommittees on Steel Forgings and Billets, and Rolled Steel Wheels and Steel Tires for many years. He was elected to honorary membership in Committee A-1 in 1952 in recognition of his valued contributions to the projects of this group. He had been a member of the Pittsburgh District Council for six years. A graduate of Pennsylvania State University, Mr. Steigerwalt had been associated with the United States Steel Corp. for 44 years. His technical society affiliations included the American Iron and Steel Inst., American Railway Engineering Assn., Transit Assn., Society or Metals, the Railways Clubs of Pittsburgh and New York, and the Engineering Society for Western Pennsylvania.

Clifford Richard Stewart, Vice-President and Secretary and Manager, Faber Labora-

(*Continued on page 102*)



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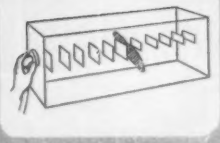

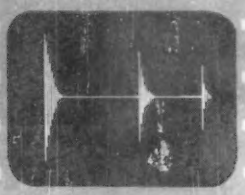

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(*Continued from page 100*)

tories of Los Angeles, Inc., Los Angeles, Calif. Member since 1932.

O. T. Tolson, Physical Testing Engineer, Texas Testing Laboratories, Inc., Dallas, Tex. Member since 1946.

Oscar Rey Varela, Electrochemist Consultant, Buenos Aires, Argentina. Member since 1953.

Calvert C. Wright, Professor and Chief, Division of Fuel Technology, Pennsylvania State University, State College, Pa. (February 1, 1954). Member of the Society and of Committee D-5 on Coal and Coke, and its Subcommittee on Methods of Analysis, since 1949. His services to this group for the study and improvement of fuel testing methods and standardization were "faithful, generous, technically brilliant, and of great benefit to the Society." An authority in his field, he held United States and Canadian patents on stokers, and had written 75 tec! nical papers and bulletins on constitutic ., processing, and utilization of fuels. A..ong other groups he was a member of the American Chemical Society, American Institute of Mining and Metallurgical Engineers, American Gas Assn., and the American Society of Heating and Ventilating Engineers.

H. M. LAWRENCE

We deeply regret to announce the death on April 6 of H. M. Lawrence, Staff Engineer of the American Standards Association. Mr. Lawrence's primary responsibility was that of following the work of ASTM and the many recommendations from the Society to the ASA with respect to the approval of ASTM standards as American Standard under ASA procedure.

His education was that of Mining Engineer and he had a number of contributions in that field to his credit. But in later years he was looked upon as a Materials Engineer following as he did the work of the ASTM. He attended its annual meetings regularly and was a familiar figure at many of the committee meetings, particularly in the fields of coal, steel, petroleum products, cement and concrete, rubber, plastics, but including many others. He was often called upon to explain to ASTM groups the operations of the ASA, and of the International Organization for Standardization (ISO) as well. His association with the ASTM committees proved most helpful in many respects.

His many friends in ASTM will keenly miss his genial personality and his sincerity in seeking cooperation and in advancing the cause of standardization in general. His genuineness and open-heartedness endeared him to many and he will be sorely missed.

An invitation to all members

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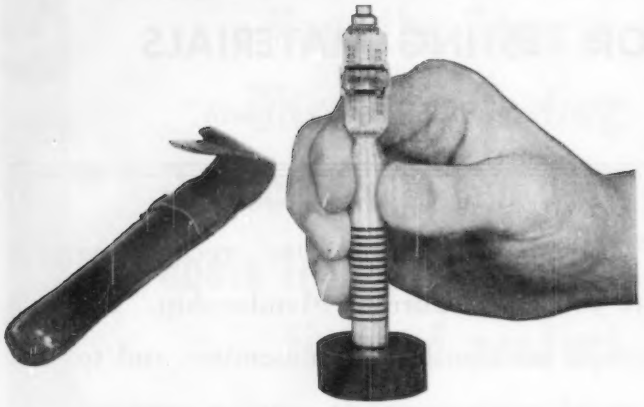

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Portable Comparator for Extensometers—For calibrating extensometers, compressometers, dial gages, and similar instruments (primarily those defined in ASTM Method E 83 – 52 T as Class B instruments) Baldwin-Lima-Hamilton Corp. announces a new extensometer comparator. Extensometers having gage lengths up to 10 in. and ranges up to 0.250 in. can be checked by means of this comparator. Bulletin No. 4210 gives details of operation and specifications.

Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.

Flame Spectra for Typical Inorganic Elements—A new pocket-size card which carries emission spectra for 36 of the most typical elements determinable by modern flame spectrophotometry has been made available by Beckman Instruments, Inc. Emission lines are superimposed on a full-color spectrum from 300 to 900 millimicrons. Copies available upon request. Refer to FC-220.

Beckman Instruments, Inc., South Pasadena, Calif.

Electronic Relay—An electronic relay of unusual flexibility and sensitivity which controls loads of 15 amp ac with an input current of less than five microamperes has been announced by the Chicago Apparatus Co. The relay has been designed for laboratory or industrial use for constant-temperature baths, constant-pressure or liquid level control or photoelectric counting, control or alarm systems. Additional information available from company. Request Bulletin 290-19.

Chicago Apparatus Co., 1735 N. Ashland Ave., Chicago 22, Ill.

Para-Xylene—A new chemical designed as a flash-point test standard for closed-cup devices is now available from the chemical division of the Fisher Scientific Co. It has been announced that Para-Xylene meets requirements for specific gravity and boiling range as specified in ASTM Methods D 850 and D 1078; also conforms to specifications for purity as outlined in ASTM Methods D 1015 and D 1016.

Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Pa.

Thermoelectric Metal Comparator—An instrument used for quick non-destructive sorting of mixed metal parts with varying alloy content was announced recently by General Motors Research Labs. In storage areas where bar stock or parts shipments have been scrambled inadvertently, this portable device will be of service in restoring order or reclassifying materials. The comparator also can detect chills in castings, which cause hardness differences.

General Motors Corp., General Motors Bldg., Detroit 2, Mich.

Comparison Bridge—The new Type 1604-B instrument includes a 400- cycle test frequency, in addition to the 1000 cycles and 5000 cycles. A feature of the comparison bridge is its adaptability to either direct measurement or high-speed sorting.

General Radio Co., 275 Mass. Ave., Cambridge 39, Mass.

Reichert Metallograph—William J. Hacker & Co., Inc., recently announced that components have been incorporated in the newly designed Reichert Metallograph enabling the most up-to-date methods for examining metallic surfaces. The following features were added: phase

(*Continued on page 105*)

(*Continued from page 104*)

contrast for metallurgy, interference tester for surface finish, micro hardness tester, zirconium arc illumination, vibration isolator, desk with built-in controls. Literature sent on request.

William J. Hacker & Co., Inc., 82 Beaver St., New York 5, N. Y.

Water Bath—Precision control of any temperature from 2 to 65 C is maintained in a new water bath recently announced by Kinetic Instrument Co. The temperature is normally held within 0.005 C over the entire range through the application of infrared energy which provides good distribution throughout the water with low operating thermal lag. Complete information available from the company.

Kinetic Instrument Co., Highland Park, Ill.

Indicator Speeds up Measurements—A new electronic measuring instrument in many cases 100 times faster and more consistently accurate than conventional galvanometers for making bridge-type measurements has been developed by Minneapolis-Honeywell Regulator Co.'s Industrial Div., it was recently announced. The instrument, called an ElectroniK Null Indicator speeds up resistance and potential measurement by utilizing precision potentiometers and bridges. Data Sheet 10.0-12 gives complete information.

Minneapolis-Honeywell Regulator Co., Industrial Div., Philadelphia, Pa.

Lightweight Radiation Detector Fits in Pocket—A new, lightweight radiation detector (PW 4010) that easily fits a man's pocket is available from the Research & Control Instruments Div., North American Philips Co., Inc. It is useful for measuring radiation exposure of laboratory workers and for checking intensity levels during research investigations.

North American Philips Co., Inc., Mount Vernon, N. Y.

The Thermonitor—E. H. Sargent & Co. announces a new thermistor actuated, proportioning, noninterrupting high precision temperature controller. Named the Thermonitor, Model S, this unit supplies controlled heat for either oil or water baths up to a volume of 15 l. The unit has an operating sensitivity of ±0.01 C. For complete data on this item S-82050, address Advertising Dept.

E. H. Sargent & Co., 4647 W. Foster Ave., Chicago 30, Ill.

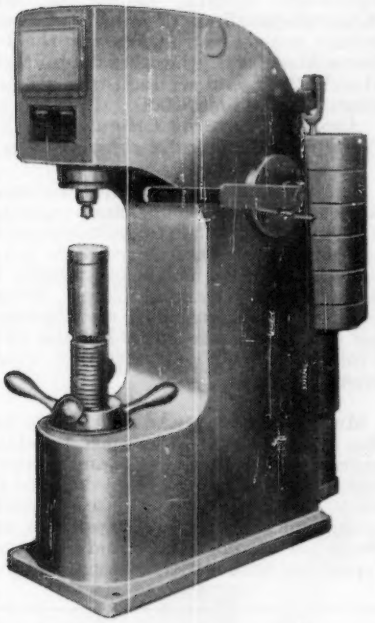
New Advance in Hardness Testing—A hardness testing instrument, making only the most minute scratches which cannot be seen with the naked eye has been placed on the market by George Scherr Co., Inc. It combines a positive controlled diamond penetrating action with a high power microscope of 400 magnifications. Instructions and tables are furnished with the instrument converting readings into Rockwell and other standard hardness scales in use.

George Scherr Co., Inc., 200 Lafayette St., New York 12, N. Y.

Dalin Distillation Apparatus—Announcement is made by the Scientific Glass Apparatus Co., Inc., of a new development in distillation equipment for laboratories and pilot plants known as the Dalin Distillation Apparatus. It is claimed that charges ranging from 2 ml to 72 l are easily fractionated; also that standard columns can be supplied with boilup rates as high as 30 l per hour, de-

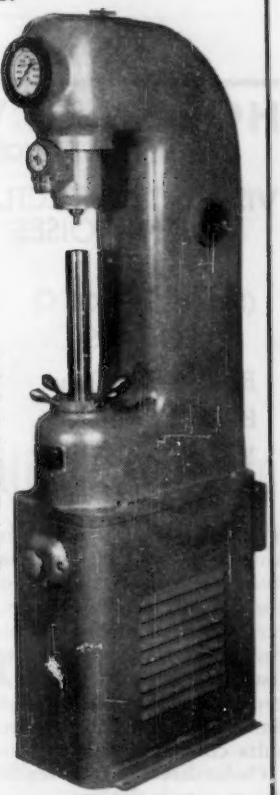
(*Continued on page 106*)

YOU CAN ALWAYS DEPEND ON *Steel City* TO FURNISH THE *Right* BRINELL HARDNESS TESTER FOR *Your* NEEDS



Individual requirements differ. Laboratory needs are far different from production needs. The Brinell Hardness Tester you buy must be exactly suited to your application. Our complete line of Brinell Testers includes the correct type for practically every need. Our reputation in this field since 1914 proves that if we do not have what you require, we can easily convert one of our standard models to fit your specifications. On this page are illustrations of two typical Steel City Brinell Testers. Other types available include portable, bridge type, deep-throated and long stroke designs and models to fit into your conveyor line. Write to us for a descriptive catalogue or address of our nearest sales representative.

Dead weight type, manually operated, bench mounted Brinell Hardness Tester. Weights are linked mechanically to ball penetrator. Dash pot below weights makes load application gradual and smooth. Instantaneously select any load 500 kg. to 3000 kg. Exceptionally accurate; low maintenance. Also available as floor model and motorized.



Direct reading type, hydraulically operated, motor driven Brinell Hardness Testing Machine for production line testing. "Direct reading" feature eliminates time-consuming use of Brinell microscope, sometimes avoids spot-grinding. Interval timer automatically controls testing cycle. Simplified knee switch operation. Tests up to 800 pieces per hour.

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Steel City Testing Machines Inc.

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(*Continued from page 105*)

pending upon the diameter or the column and the packing. For complete information write to the company, Dept. D.

Scientific Glass Apparatus Co., Inc., 100 Lakewood Terrace, Bloomfield, N. J.

Portable Temperature Test Chamber—The new, improved TC-2 Temperature Test Chamber is available from Statham Development Corp., superseding Model TC-1. The range has been extended 75 deg permitting tests from −65 to +350 F. The chamber is suited for ambient temperature variation tests of small products such as basic instruments, electronic subassemblies, components, paints, foods, dyes, textiles, organic materials, plastics, rubber, hydraulic or pneumatic accessories. Descriptive bulletin available upon request.

Statham Development Corp., 12411 W. Olympic Blvd., Los Angeles 64, Calif.

CATALOGS AND LITERATURE

Freezing-Point Depression Apparatus—A new freezing-point depression apparatus is described in an illustrated two-page bulletin by American Instrument Co., Inc. The apparatus consists essentially of two parts: a thermistor bridge null-detecting unit; and a freezing unit. Among its uses are the determination of osmotic pressure, molecular weight of some water-soluble compounds and molecular weight of many organic compounds soluble in benzol. Apparatus is described in Bulletin 2248.

American Instrument Co., Inc., Silver Spring, Md.

Optical Emission Quantometers—A new bulletin describing Optical Emission "Quantometers" has been published by Applied Research Laboratories. This instrument for routine analytical production control problems allows chemical analyses to be made quickly and accurately. In an eight-page bulletin, models of three "Quantometers" are described: two production control instruments, one the Two Meter Model 9500, the other the 1.5 Meter Model 7200; and an industrial research instrument, Model 8200.

Applied Research Laboratories, 3717 Park Place, Glendale 8, Calif.

Sonntag Impact Machines—Universal impact machines with maximum capacities of 240 ft-lb and 48 ft-lb for metals and plastics, respectively, are described in a new four-page bulletin published recently by Baldwin-Lima-Hamilton Corp. Design features of these machines are illustrated and specifications listed in Bulletin 4211.

Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.

Multicell Heaters—An information bulletin available from G. F. Bush Associates describes the multicell heater and mentions that the individual cells may be used for many purposes; some uses include: aging, immersion and swelling studies, and effects of temperature and pressure. Topics deal with controls, design features, and specifications. Heaters can be supplied in any multiple of nine cells.

G. F. Bush Associates, Box 175, Princeton, N. J.

Use and Care of Brookfield Viscometer—Now available from Brookfield Engineering Laboratories is an informative, 20-page booklet entitled "Solutions to Sticky Problems." The booklet includes a general description of the Brookfield Viscometer, describes its use and factors to be avoided, and explains proper operating procedure. Some of the topics include: simple calibration check, making a good measurement, sensitivity, viscosity and temperature, rheology, and recalibration.

Brookfield Engineering Labs., Inc., 240 Cushing St., Stoughton, Mass.

Listing of Scientific Instruments—Central Scientific Co. has issued its 1954 Lab Listing which contains 400 new items of scientific instruments and laboratory apparatus that have been added to the company listing since the publication of the company's General Catalogue J-150. The booklet, a 64-page supplement to the General Catalogue, presents photographs and descriptions of the new apparatus as well as a current price list. Copies on request.

Central Scientific Co., 1700 W. Irving Park Rd., Chicago 13, Ill.

(*Continued on page 107*)

HOEPPLER VISCOSIMETER

PRECISION MODEL

VISCOSITY DIRECTLY IN CENTIPOISES

(from 0°C to 100°C)

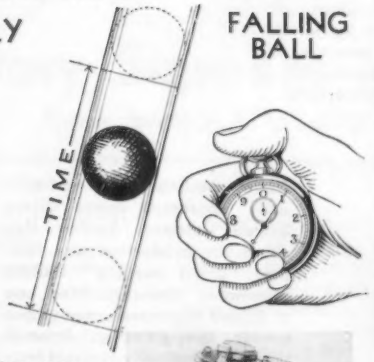
EQUALS

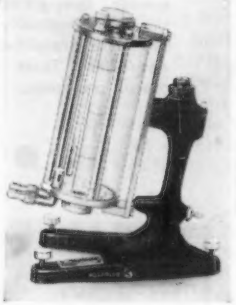
B x (Sb–Sf) x Time

B = Ball Constant,

Sb = Sp. gr. of ball

Sf = Sp. gr. of fluid





The Hoeppler Viscosimeter provides a fast and accurate method of determining the viscosity of gases, liquids, oils, plastics, syrups, viscous tars and dark colored liquids. Direct reading in centipoises (or centistokes). From 0.01 to 1,000,000 centipoises. Accuracy 0.1% to 0.5%. Small sample (30cc) required. Results consistent and reproducible.

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(*Continued from page 106*)

Recording Oscillograph—Bulletin CEC-1500C recently published by Consolidated Engineering Corp. describes Recording Oscillograph Type 5-114. The oscillograph was designed to record data of both static and highly transient or cyclic nature, and to meet requirements for a versatile, accurate, and rugged instrument. Profusely illustrated, this 16-page booklet covers the features of Type 5-114, describes the 7-300 Series Galvanometers, lists accessories and associated equipment.
Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif.

Dynamometer—Bulletin 25E available from W. C. Dillon & Co., Inc., covers the many uses devised by the company for the dynamometer. Illustrations show some applications of this force measuring gage; dimensions and prices are listed.
W. C. Dillon & Co., Inc., 14620 Keswick St., Van Nuys, Calif.

Oscillograph—A new twelve-page bulletin describing the Du Mont Type 323 wide-band Cathode-ray Oscillograph has just been published by the Instrument Div. of Allen B. Du Mont Labs., Inc. The technical booklet gives complete specifications and contains illustrations of the instrument and circuit diagrams. It is available upon request from the Technical Sales Department.
Allen B. Du Mont Laboratories, Inc., 760 Bloomfield Ave., Clifton, N. J.

High-Speed Balance—A constant-sensitivity high-speed balance has been developed by Fisher Scientific Co. This special purpose model of the Fisher Gramatic Balance is described and illustrated in an eight-page bulletin. Sensitivity (±0.05 mg) is constant throughout the entire weight range of the balance.
Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Pa.

Chemical Index—Catalog 115-C published recently by Fisher Scientific Co. lists almost every known chemical—organic and inorganic—that is available commercially and of use to science. This 304-page catalog gives structural formulas, molecular weights, melting points, boiling points, etc., for most of the chemicals, and color index numbers for dyes and stains. Melting and boiling points appearing directly beside the name are obtained from actual laboratory tests.
Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Pa.

Comparator-Microdensitometer—A new publication recently announced by The Gaertner Scientific Corp. describes the L499 Comparator-Microdensitometer. The instrument is used in the evaluation and comparison of spectrographic plates by measuring comparative densities and by comparing the unknown plate to a master plate of known value. Bulletin 190-53 lists complete specifications and details.
The Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago 14, Ill.

Laboratory Glassware Washer—A catalog issued by Heinicke Instruments describes washing principles, a mass production washer containing baskets for different types of glassware, a washer with trays for cages and bottles, and washers for medium and small laboratories.

(*Continued on page 108*)

IT TAKES TOP INSTRUMENTATION TO DO TOP RESEARCH

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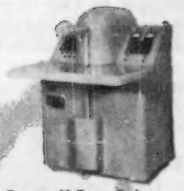

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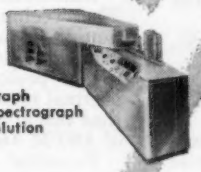

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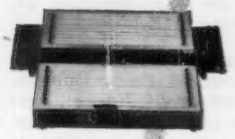
A completely automatic spectrograph with outstanding resolution and dispersion



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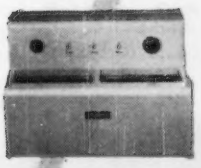
Combines high sensitivity and high linearity with ease of use



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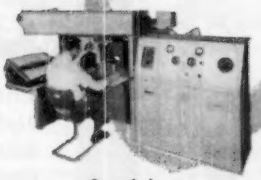

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(*Continued from page 107*)

Catalog also contains performanee table of different model washers.
Heinicke Instruments, 2035 Harding St., Hollywood, Fla.

Automatic Sulfur Titrator—A descriptive data sheet issued by Laboratory Equipment Corp. deals with the newest addition to the line of chemical analysis apparatus. Designated as ET-20, this iodometric titration unit is used for the analysis of sulfur in iron and steel by the combustion method.
Laboratory Equipment Corp., St. Joseph, Mich.

Electric Water Heater—Specifications No. 1500 describe the electric water heater announced by Parr Instrument Co. This heater maintains a 2.5-liter supply of hot water at line pressure under automatic temperature control for use with water baths, calorimeters, and other laboratory devices requiring a ready hot water source. Copies mailed on request.
Parr Instrument Co., 211 Fifty-third St., Moline, Ill.

Ionographs—Precision Scientific Co. announces a new Bulletin No. 690 on its Senior and Junior Ionographs. These new instruments perform electrophoretic separations on wet filter paper, as in fractionation of mixtures of proteins, carbohydrates, amino acids or vitamins, mobility determinations, and reaction-site studies. The technique of ionography is fully described and illustrations of the instruments and their components are included. Free copy of this eight-page bulletin on request.
Precision Scientific Co., 3737 W. Cortland St., Chicago 47, Ill.

Recording Equipment—A recent issue of *Right Angle* published by the Industrial Div. of Sanborn Co. features an article entitled "Differential Input Circuits." Additional information from the company.
Sanborn Co., Industrial Div., Cambridge 39, Mass.

Scientific Apparatus and Methods—A recent issue of "Scientific Apparatus and Methods," released by E. H. Sargent and Co., features two articles, one covering thermistor actuated temperature regulation and the other dealing with principles of the thermonitor circuit. A section is included listing new and reinstated items.
E. H. Sargent and Co., 4647 W. Foster Ave., Chicago 30, Ill.

Automatic Grease Working Machine—The Technical Equipment Co. has announced a machine suitable for testing the shear stability of liquids and plastic solids under prolonged and reproducible isothermal mechanical working. It is stated that this apparatus meets all requirements of ASTM Method D 217.
Technical Equipment Co., 743 Dwight Way, Berkeley 10, Calif.

Densigraph (Recording Densitometer)—A 2-page bulletin describes a new, manually operated recorder (Densigraph) for rapid photometric analysis of light-absorbing materials on *dry* paper strips as obtained in electrophoresis and chromatography. Gives complete information about operation, application and specifications. (*Bulletin No. 117.*)
Arthur H. Thomas Co., 230 S. 7th St., Philadelphia 5, Pa.

INSTRUMENT COMPANY NEWS

Adolph I. Buehler, Evanston, Ill.—Alfred J. Amsler & Co. of Schaffhouse, Switzerland, manufacturers of a complete line of testing machines, and represented in the United States and Canada by Adolph I. Buehler, will celebrate its 100th birthday this June. Famous for its precision instruments, the Amsler type of hydraulic material testing machine, and the pendulum dynamometer, represent but two of the many outstanding achievements by this firm in the material testing field.

Arthur D. Little, Inc., Cambridge, Mass.—A West Coast office has been opened at the Adam Grant Building, Room 1028, 114 Sansome St., San Francisco 4, Calif., according to a recent company announcement. Christian J. Matthew will be in charge.

North American Philips Co., Inc., Mount Vernon, N. Y.—Appointment of W. A. Schlueter as dealer in the southwest for products of the Research & Control

(*Continued on page 109*)

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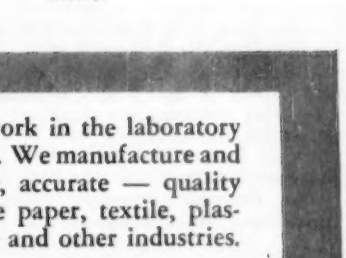

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(*Continued from page 108*)

Instruments Division has been announced by C. J. Woods, national sales manager. The new organization will be known as the Southwestern Electronics Corp. and will be located on May 1 at 3920 S. Peoria Ave. in Tulsa.

Precision Potentiometers Corp., Los Angeles, Calif.—Recently organized as a majority-owned subsidiary of Master Mobile Mounts, Inc., the company will manufacture high-precision potentiometers and precision windings, it was announced by Samuel E. Goldstein, president of the two companies. The potentiometer company address is 1243 W. Pico Boulevard.

Scott Testers, Inc., Providence, R. I.—At the ASTM Exhibit in Chicago, the company will show the latest developments in physical test apparatus for evaluating elastomers, textiles, wire, and other materials, within the range from 0 to 2000 lb tensile. Featured in Booth No. 1 will be the first public showing of the Model LG Aluminum Block Heating Bath for temperature aging tests (ASTM Method D 865) at temperatures up to 600 F. Also on display will be the Scott L-6 Tensile Tester for rubber and high elongation materials. In addition the "Acer-O-Meter" Weighing System for Constant-Rate-of-Extension testing with electronic recording will be a part of the show.

Foster D. Snell, Inc., New York, N. Y.—Announcement of the return of Marshall N. Levin to the New York Office as Editor of "Chemical Market Abstracts" has been made by Foster D. Snell, Inc. Mr. Levin has been in Europe for the past two years as European Correspondent for the journal.

Sperry Products, Inc., Danbury, Conn. Two of the company's latest model ultrasonic reflectoscopes will be exhibited in Booth No. 66 at the ASTM Exhibit in Chicago. The instruments will be operated in an actual demonstration of the inspection of raw materials and finished parts. Explanations will be given of the various methods of testing possible with this instrument to enable it to meet the requirements, not only of different industries but also of varied applications. A large blackboard will be used to illustrate and discuss visitors' testing problems.

Tenney Engineering, Union, N. J.—A new plant, now in full scale operation at 1090 Springfield Rd., consolidates and enlarges previous facilities of the old headquarters plant.

Blood Plasma Process

Blood plasma processing for the armed services in a Michigan processing station is safeguarded from mainline power interruption by a standby Diesel-electric set manufactured by the Detroit Diesel Engine Division of General Motors. The set was installed because any interruption of the 48-hour process could result in loss of plasma as well as damage to processing machinery. The standby unit is fully automatic in its operation.

Instruments for Testing
CEMENT AND CEMENTITIOUS MATERIALS

CEMENT AUTOCLAVE

For making ASTM (C151) volume change and soundness tests of portland cement. Consists of a high-pressure electrically-heated steam autoclave tested to 1000 psi, automatic pressure control, code-approved safety pop valve, pressure release valve, 600-lb. dial gage, and multi-prism specimen holder. Will not leak steam even at maximum pressure.

CONCRETE BEAM TESTER

For determining flexural strength of 6 × 6 × 18-in. specimen concrete beams according to ASTM C78 and A.A.S.H.O. T-97. Flexural strength capacity, 1250 psi (15,000-lb. load). One division (one hundredth of a revolution) on the dial of the gage corresponds to an applied load of 120-lb., which corresponds to a flexural strength (modulus of rupture) of 10 psi.

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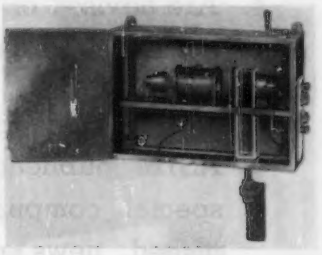
Meets the latest ASTM requirements for determining flow (consistency) of cement (C 87; C109; C124; C230; C243; C255). Motor-driven table shaft and cam revolve at 108 rpm, resulting in 25 drops (1/2 or 1/8-in.) of the 10-in. diameter table in about 14 seconds. Motor drive and mounting bracket may be purchased separately for attachment to manually-operated flow tables already in use, provided such tables meet the latest ASTM specifications.



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Determines actual particle size distribution down to 7.5 microns in several minutes.

All parts permanently aligned; positive protection against accidental overload of the microammeter; sedimentation tank does not come in contact with the mechanism of the instrument; 3-point mounting facilitates installation on uneven walls.

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Calendar of Other Societies' Events

"Long" and "short" calendars will appear in alternate BULLETINS. The "short" calendar notes meetings in the few immediate weeks ahead—the "long" calendar for months ahead.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—May 17–19, Appliance Technical Conference, Morrison Hotel, Chicago, Ill.

AMERICAN IRON AND STEEL INSTITUTE—May 26–27, General Meeting, Waldorf-Astoria, New York, N. Y.

SOCIETY OF AUTOMOTIVE ENGINEERS—June 6–11, Summer Meeting, Ambassador Hotel, Atlantic City, N. J.

THE SOCIETY OF THE PLASTICS INDUSTRY, INC.—June 7–10, Sixth National Plastics Exposition, Cleveland, Ohio.

AMERICAN SOCIETY FOR QUALITY CONTROL—June 9–11, National Convention, Kiel Auditorium, St. Louis, Mo.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS—June 14–17, Oil & Gas Power Conference, Hotel Muehlebach, Kansas City, Mo.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS—June 14–18, 2nd U. S. Congress of Theo. & Applied Mechanics, Univ. of Michigan, Ann Arbor, Mich.

AMERICAN SOCIETY FOR ENGINEERING EDUCATION—June 14–18, Annual Meeting, University of Illinois, Urbana, Ill.

AMERICAN SOCIETY OF CIVIL ENGINEERS—June 14–19, Convention, Chalfonte-Haddon Hall, Atlantic City, N. J.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS—June 20–24, Semi-Annual Meeting, William Penn Hotel, Pittsburgh, Pa.

AMERICAN INSTITUTE CHEMICAL ENGINEERS—June 20–25, Internatl. Meeting on Chem. Engineering Aspects of Nuclear Processes, Univ. of Michigan, Ann Arbor, Mich.

INSTITUTE OF THE AERONAUTICAL SCIENCES—June 21–24, Annual Summer Meeting, IAS Building, Los Angeles, Calif.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—June 21–25, General Meeting, Hotel Biltmore, Los Angeles, Calif.

ACOUSTICAL SOCIETY OF AMERICA—June 23–26, Annual Meeting, New York, N. Y.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS—June 28–30, Semi-Annual Meeting, New Ocean House, Swampscott, Mass.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS—July 11–14, Semi-Annual Meeting, Olympic Hotel, Seattle, Wash.

INSTITUTE OF THE AERONAUTICAL SCIENCES, INC.—August 9–11, Turbine Powered Air Transportation, Seattle, Wash.

SOCIETY OF AUTOMOTIVE ENGINEERS—August 16–18, West Coast Meeting, Hotel Statler, Los Angeles, Calif.

Effect of Light on Coated Groundwood Papers

PAPERS containing groundwood fibers, made by disintegrating logs against large grinding stones, are of considerable importance commercially. Newsprint contains about 75 per cent groundwood, and other printing papers for use in less permanent types of publications also have large percentages of this fiber.

While groundwood is one of the cheapest papermaking fibers, it is unsuited to many uses because it turns yellow very rapidly when exposed to light. How-

(Continued on page 111)

ever, some protection from the effects of light is afforded by a clay coating which is frequently added to achieve a better printing surface. This coating consists of very finely divided clay mixed with starch, glue, casein, or synthetic resin as a binder. In an effort to determine the degree of such protection provided to groundwood papers by commercial clay coatings, the National Bureau of Standards recently made a study of the effect of light on the coated papers.

The light source was a carbon-arc lamp with a cupric chloride filter and heat exchanger to remove the infrared. The filtered light was selected to correspond as closely as possible to skylight filtered by ordinary window glass, but its intensity was considerably higher. Constancy of light dosage was checked by means of a light meter.

Because the light which a paper normally receives is not sufficient to raise its temperature, and because photochemical reactions are frequently temperature-dependent, the papers were maintained at temperatures between 31 and 33 C during irradiation. The paper was held against a water-jacketed backing plate by drawing air continuously through the sheet. This air stream passed out of the enclosed irradiation chamber in which the backing plate was mounted, circulated in a closed system over a saturated solution of sodium bromide maintained at 30.0 ± 0.2 C in a constant temperature bath, and then returned to the irradiation chamber. The bromide solution maintained the relative humidity at about 57 per cent. The water circulating through the aluminum backing was drawn from the constant temperature bath.

The degradation of the coated groundwood papers was compared with that of coated papers containing no groundwood as well as uncoated papers, with and without groundwood. It was found that a clay coating gives considerable protection against the degrading effects of light. In fact, the yellowing of the coated groundwood fibers was only about half that of the uncoated fibers of similar composition. However, groundwood is so light-sensitive that coated groundwood papers are still much less stable than are good quality papers without coating.

Under the conditions of the experiments, the coated papers containing no groundwood were not degraded to a measurable extent. In contrast to the groundwood papers, degradation of uncoated papers which contained no groundwood was accompanied by bleaching.

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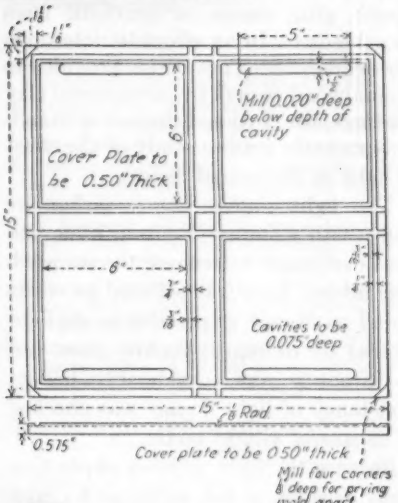
5"
Mill 0.020" deep below depth of cavity
Cover Plate to be 0.50" Thick
6"
15"
Cavities to be 0.075 deep
0.515"
Cover plate to be 0.50" thick
Mill four corners ⅛ deep for prying mold apart

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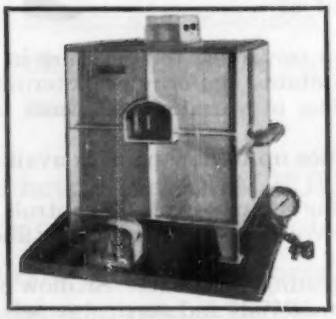
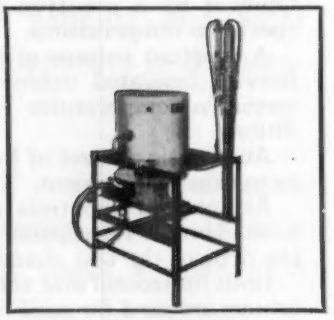


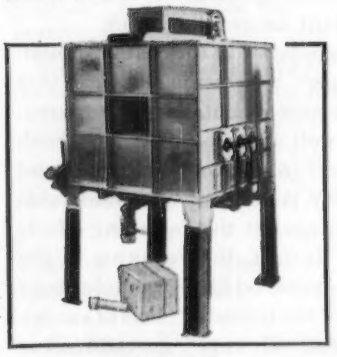
#2150

Setting Space—4½"x6½"x4". Temp. Range—1200°F. to 3100°F. Over-all Dimensions—Approx. 30"x30". Type—Gas-fired, semi-muffle; full muffle. Fuel—Propane, natural or city gas. Stack—none required.



#1800A

Setting Space—Cone plaque holds 22 cones. Temp. Range—Cone 40, as equipped. Over-all Dimensions—33"x 53". Type—Revolving (2 RPM). Floscope controlled. Fuel—Oxygen and acetylene.



#2320

Setting Space—12"x18"x9". Temp. Range—1200° F. to 3200° F. Over-all Dimensions—Approx. 4'x4'. Type—Gas-fired, single valve control. Fuel—Propane, natural or city gas. Stack—not necessary but desirable.

#2350 (not shown)

Setting Space—24"x9"x7¼" high. Temperature Range to 3500°F.

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